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TERM provides the tank company/team with new capabilities in range and precision target engagement. This study emphasizes the use of command and control to realize the potential for increased lethality and effectiveness for the company/team using TERM.

This study investigates the increase of battlespace and the need for expanded situational awareness at the company/team level as a result of TERM. This study promotes reorganization of the scout platoon to company/team level, sensor-to-shooter linkages between scouts and TERM firing tanks, improvements to digitized equipment to improve situational awareness, and changes to the roles and functions of the company/team commander, executive officer, and fire support officer. The proposed command and control configuration promotes optimal use of TERM, which in turn optimizes the effectiveness of the tank company/team.

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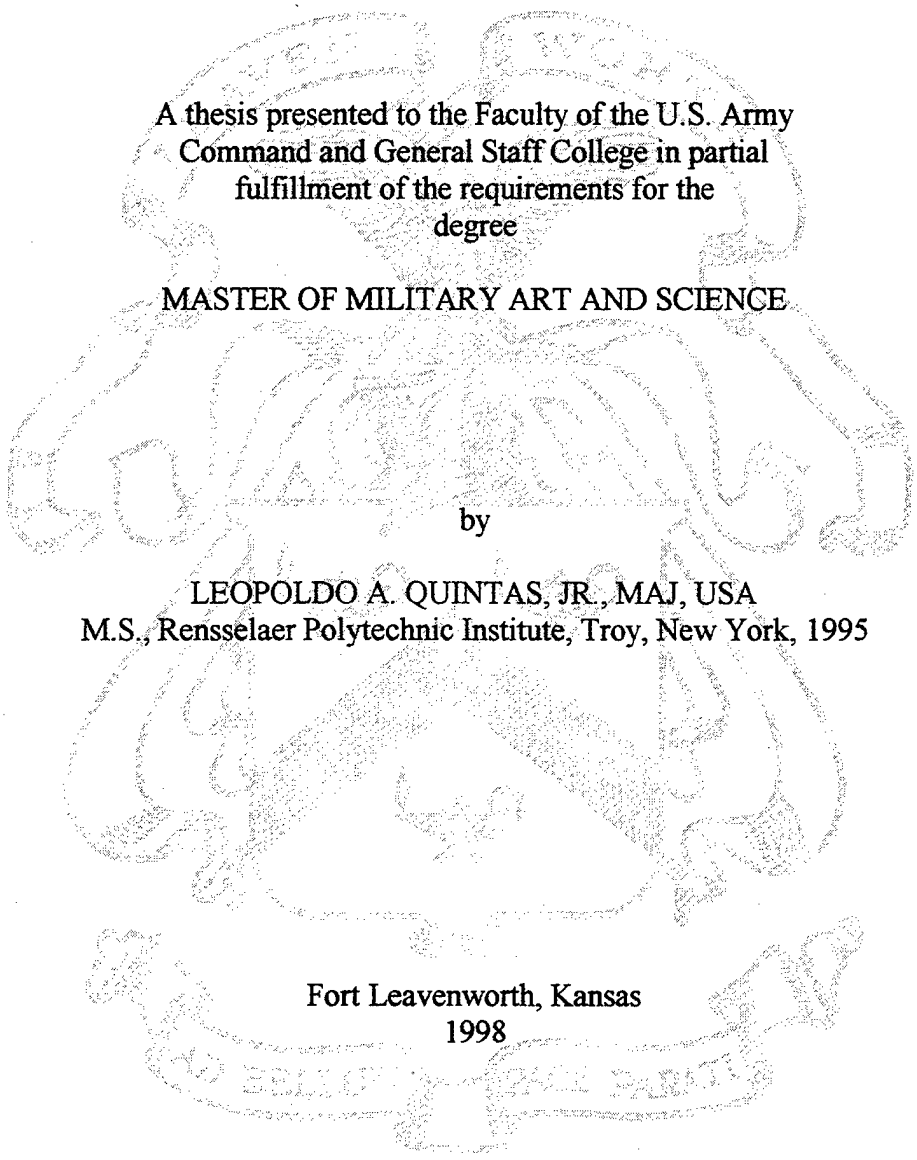

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (Reference to this study should include the foregoing statement.)

ABSTRACT

COMMAND AND CONTROL OF THE TANK COMPANY/TEAM USING TANK EXTENDED RANGE MUNTIONS, by MAJ Leopoldo A. Quintas, Jr., USA, 88 pages.

This study investigates the use of Tank Extended Range Munition (TERM) at the company/team level. From the company/team perspective this study attempts to determine the command and control configuration that maximizes the effectiveness of TERM. This study recommends changes to the current command and control configuration with regard to organization, procedure, equipment, and personnel.

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I would like to express special thanks to Captain William T. Harris III, a fellow Armor Officer and student. As a member of the Mounted Maneuver Battlespace Laboratory (MMBL) at Fort Knox, Kentucky, Captain Harris provided information critical to this paper. On his own initiative Captain Harris made the effort to compile and send much needed information with regard to TERM. Captain Harris' assistance included gathering research and data previous to his simulations at MMBL, a list of points of contact related to my research, and a complete access to his ongoing work with regard to TERM. Without his assistance, this thesis would certainly have been more difficult and less comprehensive.

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LIST OF ABBREVIATIONS

2IC	Second in Command
AGM	Attack Guidance Matrix
AO	Area of Operations
ATGM	Antitank Guided Missile
B2C2	Battalion and Below Command and Control
BDA	Battle Damage Assessment
BLEP	Battle Lab Experimentation Plan
BLOS	Beyond Line of Sight
C2V	Command and Control Vehicle
CAS	Close Air Support
CITV	Commander's Independent Thermal Viewer
CO	Company
COA	Course of Action
DU	Depleted Uranium
EXFOR	Experimental Force
FA	Field Artillery
FLIR	Forward Looking Infrared Radar
FM	Field Manual
FRAGO	Fragmentary Order
FSCS	Future Scout and Cavalry System
FSO	Fire Support Officer

HEAT	High Explosive Antitank
HUD	Heads-Up Display
IVIS	Intervehicular Information System
KE	Kinetic Energy
LER	Loss Exchange Ratio
LOS	Line of Sight
M1A1	Abrams Main Battle Tank
M1A2	Abrams Main Battle Tank (digitized version)
M2A2	Bradley Fighting Vehicle
MMBL	Mounted Maneuver Battlespace Laboratory
MMW	Millimeter Wave Radar
NBC	Nuclear, Biological, Chemical
NCO	Noncommissioned Officer
NTC	National Training Center
NTC-IS	National Training Center Instrumentation System
OC	Observer Controller
ODH	Operation Desert Hammer
OPSEC	Operational Security
PIR	Priority Intelligence Requirement
PLT	Platoon
S3	Battalion Operations Officer

S-S	Sensor-to-shooter
ST	Special Text
TC	Tank Commander
TERM	Tank Extended Range Munition
TOC	Tactical Operations Center
TOW	Tube Launched Optically Tracked Wire guided
TRADOC	Training and Doctrine Command
XO	Executive Officer

CHAPTER 1

INTRODUCTION

Introduction to the Problem

Command and control consists of the means by which the commander manages his forces to attain decisive action. Without proper command and control, the commander cannot make full use of his assets, putting himself, his force, and his mission at risk. The soon-to-be-published final draft of Field Manual (FM) 100-5, *Operations*, states that, "commanders must be able to orchestrate the full range of actions that make up their operations."[1] With the introduction of new systems of weapons and communications, new organizations, and new capabilities, command and control becomes an ever-increasing problem. This thesis deals with command and control of the tank company/team and concerns with incorporating personnel, equipment, organization, and procedures.

The Research Question

This study answers the primary research question: How does the tank company/team command and control its forces to maximize the use of Tank Extended Range Munition (TERM)? As a critical subordinate question this study answers the following question: What benefits does TERM provide the company/team? Additionally, this study answers the critical subordinate research question: What is the optimal company/team organization that takes advantage of TERM? Finally, this study

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[1] Final Draft to Headquarters, U.S. Department of the Army, FM 100-5, *Operations* (Washington, DC, 5 August 1997), 6-7.

answers the critical subordinate research question: What are the assets available that will provide command and control options to the company/team?

Background or Context of the Problem and the Research Question

TERM is a new type of tank ammunition. TERM is a "smart" munition fired by the main gun of the Abrams Main Battle Tank, Digitized Model (M1A2) at targets up to ten kilometers away. This new capability promises significant returns with regard to combat power. Recent simulations with TERM indicates that the tank company/team can destroy more than twice the number of enemy vehicles while retaining more than one-third of its combat power, compared to a standard tank company/team.[2] With TERM, the firing tank may acquire the target by itself or from a flank vehicle with intervisibility to the target as shown in figure 1.

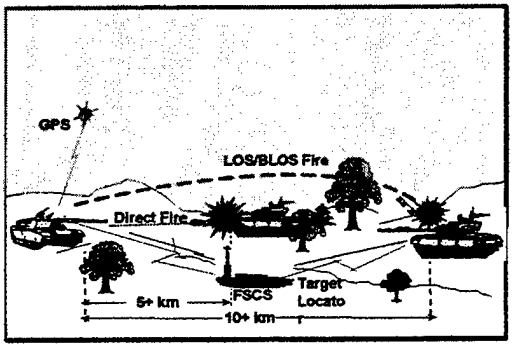

Figure 1. TERM Concept

More likely, reconnaissance vehicles will identify the enemy from positions well forward of the armor main body. For the first time, tanks will have the capability to engage

targets with organic weapon systems far beyond direct-fire range and Beyond Line of Sight (BLOS).

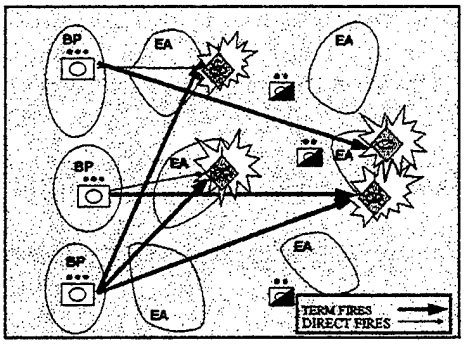

Figure 2. Concept of TERM Tactics

The extended engagement ranges offered by TERM greatly increase the battlespace of the company/team commander. Because of the increased capabilities provided by TERM, it is reasonable to expect the area of operations for a company/team commander to expand to an area previously covered by a battalion/task force. Because of TERM, the company/team will mass fires over extended distances. For example, a platoon may now have an engagement area for direct fires (from the immediate front to 3,000 meters) and another engagement area up to ten kilometers distant. The company/team commander will have multiple company/team engagement areas, with platoons firing into engagement areas with direct or indirect fires. For the first time the company/team will achieve massed fires in several engagement areas at the same time as seen in figure 2.

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[2] George L. Seffers, "Army Seeks Smart Munitions to Double Abrams Range," *Army Times*, 29 September 1997, 25.

The challenge of command and control lies in managing the company/team's ability to mass fires at different ranges and at different locations to gain decisive action. In other words, the commander's battlespace and the difficulties in managing a larger battlespace have significantly expanded.

With the ability to destroy the enemy with precision ammunitions at over thrice the range of direct-fire weapons, TERM offers the armor commander the option of destroying a significant portion of enemy formations prior to direct-fire combat. For the first time, the armor company/team will engage the enemy with organic long-range precision weapons prior to becoming decisively engaged.

The long-range capability of TERM, along with the implementation of Force XXI, requires the company/team commander to assume responsibility over an ever-increasing area of operations. TERM becomes a critical asset to the commander, allowing him to exert control over this expanded area. The challenge arises in attempting to command and control dispersed subelements, cover a wider and deeper area of responsibility, and mass fires for the desired effect. While the introduction of TERM pose significant considerations for battalion/task force command and control and higher levels, the true challenge and the focus of this study are the command and control issues for the company/team.

Assumptions

Several critical assumptions support this thesis. This study assumes that simulations conducted with TERM are fair estimates of their performance on the battlefield. Because TERM has not yet been fielded or tested by tactical units, simulations provide the best approximation of the ammunitions' capabilities.

This study assumes that the command and control options for the company/team are quantifiable, so that a "best" system may be selected.

Another assumption is the timely, integrated fielding of key weapon systems and components, to include the Future Scout and Cavalry System (FSCS), M1A2 Main Battle Tank, TERM, as well as proposed command and control links at the battalion/task force level and lower. This assumption ensures a digitized battlefield and the necessary links and situational awareness to properly implement TERM.

The Future Scout and Cavalry System (FSCS) provides reconnaissance elements with several critical capabilities. Included in the FSCS is a full suite of sensors. Sensors include second generation Forward Looking Infrared (FLIR), Millimeter Wave (MMW) Radar, low-light level television and acoustic sensors. This sensor suite allows FSCS equipped scouts to detect and to identify the enemy at extended ranges. The FSCS also possesses a Far Target Laser designator and seamless digital communications.[3] Designation and seamless communications allow scouts to relay situational awareness to TERM equipped M1A2s within the company/team that is critical to effective TERM use.

The M1A2 possesses a digital system compatible with the FSCS. This technology is critical to establishing the sensor-to-shooter link required for firing TERM. Additionally, onboard fire control allows the crew to fire TERM, based on threat information received from scout vehicles. The tank's ballistic computer lays and fires the

[3] William T. Harris and Ken Hunt, "Battlelab Experimentation Plan for Force XXI Armor Battalion Redesign-DRAFT," (Fort Knox, KY: Mounted Maneuver Battlespace Lab, 23 June 1997) 3-5.

gun with minimal crew effort. This capability ensures timely and accurate firing of TERM.

This study assumes that lessons learned by the Field Artillery (FA) Branch are applicable to TERM considerations. The FA community is necessarily made up of recognized experts in dealing with indirect fire. TERM, as an indirect fire weapon, may have command and control issues already addressed by the FA community. In particular, the FA community struggled with the effectiveness of Copperhead ammunition, an ammunition possessing similarities to TERM, which bears further investigation. Additionally, the issues the FA community will have with new sensor-to-shooter technology, new command and control components, and new weapons and munitions may have a bearing on the issues presented by TERM. The similarities between indirect fires from FA and the use of TERM may provide useful insights and common solutions to command and control considerations.

Definitions

To determine how the tank company/team will command and control its forces to maximize TERM, this study identifies a best command and control configuration. Before determining the best command and control configuration for the company/team using TERM, command and control is first defined. The concept command and control follows the definition in FM 101-5-1, which describes command and control as those functions that are performed through an arrangement of personnel, equipment, communications,

facilities, and procedures employed by the commander to accomplish the mission.[4] This study determines the optimal arrangement of personnel, equipment, organization, and procedures, hereafter known as "command and control configurations" that maximize the strengths of TERM and answer the primary thesis question.

An integral portion of this thesis involves the analysis of a set of courses of action from simulations performed by the Mounted Maneuver Battlespace Laboratory (MMBL) at Fort Knox, Kentucky. This thesis evaluates these courses of action to determine the best organization for the company/team and the significant components of the command and control structure for the company/team. The criteria used to determine the best course of action require definition.

Loss Exchange Ratio (LER) is the first criterion used in evaluating command and control courses of action. LER is the ratio of enemy to friendly losses during a combat simulation.

Percentage of kills Beyond Line-of-Sight (BLOS) is the second criterion. This criterion provides a percentage of the total kills accomplished by TERM fires in the indirect fire mode, from 5,000 to 10,000 meters from the firing tanks.

Direct fire kills beyond 3,000 meters is the third criterion. This criterion provides the percentage of kills accomplished by TERM fires in the direct fire mode, from 3,000 to 5,000 meters.

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[4] Headquarters, U.S. Department of the Army, FM 101-5-1 *Operational Terms and Graphics* (Washington, DC, 30 September 1997), 1-33.

Percentage of scouts destroyed is the fourth criterion. This measurement provides the percentage of FSCS destroyed during a combat simulation. Scouts destroyed include those killed by fratricides.

Average rounds fired per kill is the fifth evaluation criterion. This average provides the mean number of tank rounds of all types that were fired to destroy one enemy target during a course of action simulation.

Percentage of overkills is the sixth evaluation criterion. This criterion measures the percentage of redundant hits by all types of tank rounds on enemy vehicles during a course of action simulation.

Frequency of backup-shooter engagements is the seventh criterion. This criterion measures the average number of times a course of action had to hand off a target from its primary shooter to an alternate firer.

The MMBL simulation did not measure the final evaluation criterion, Leadership. Leadership is the fourth and final dynamic of combat power. "The most essential dynamic of combat power *is competent and confident officer and noncommissioned officer leadership.* Leaders inspire soldiers with the will to win."[5] Each configuration is evaluated in terms of leadership. Configurations that maximize the opportunities for leaders to provide direction and motivation at the decisive point on the battlefield receive the highest ratings in leadership. The leadership's ability to directly influence the fight by their personal presence, audio, or electronic link receives special consideration.

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[5] Headquarters, U.S. Department of the Army, Field Manual 100-5 *Operations* (Washington, DC, 14 June 1993), 2-11.

Limitations

Because TERM is a new and unfielded munition, much of the information about them comes from simulations. Inherent limitations in working with simulations include constraints imposed by the experimenter. Current simulations with TERM present several limitations. In a large part, command and control issues were not designed into the simulation.

Simulations used no artillery or aviation assets. Accordingly, there were no resulting command and control problems with firing artillery or higher angle TERM in airspace used by attack aviation or Close Air Support (CAS). These considerations, while ignored, present a significant challenge to the company/team commander in terms of command and control and are assessed in this study.

Sensor-to-shooter links were robust, and TERM was immediately fired following target acquisition. Simulations ignored command and control measures to determine priority of fires, targets assignment, target tracking, and Battle Damage Assessment (BDA). Essentially, tanks armed with TERM engaged a target once it was detected. The commander had virtually no input on how the battle was to be fought once the enemy was detected. In many respects no command and control was exercised once the simulated units were pointed in the right direction and sent on their way. Links were so robust that tanks fired immediately following target acquisition by the scouts. The simulation failed to account for the time involved to load TERM, position the vehicle, and fire the round. This study determines how to implement command and control linkages into the highly automated digitized environment, given the realities of combat and maneuver warfare.

Many technical aspects of TERM were not addressed. Geometry considerations between sensor and shooter that may have prevented successful engagement were not considered. The simulation failed to evaluate the lethality of TERM against an enemy armed with appropriate countermeasures. This study researches and evaluates the impact of the technological limitations of TERM.

Delimitations

This thesis considers only a conventional threat. Additionally, the Opposing Force (OPFOR) for which command and control measures are assessed is equipped with former Soviet Union equipment and use former Soviet Union doctrine and tactics.

Within the conventional war format, this study further confines itself within terrain and environmental limitations. Southwest Asia and the National Training Center (NTC) provide the terrain for this study. Simulations and Advanced Warfighting Experiments (AWEs) support this environmental consideration.

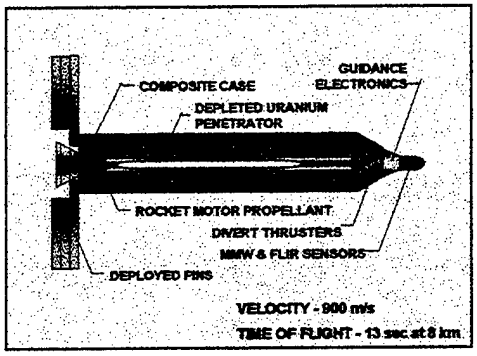

Figure 3. TERM-KE XM-1007

Additionally, in order to refine command and control considerations, this study focuses on the specific munition type of all TERM considered most likely to be fielded.

At this point, the most likely candidate appears to be the Kinetic Energy Line-of-Sight/Beyond Line-of-Sight (KE LOS/BLOS) round.

The most likely KE LOS/BLOS round appears to be the XM1007, TERM-KE Projectile (see figure 3). TERM-KE consists of a fin stabilized, thruster guided, rocket assisted, and Depleted Uranium (DU), tank round with an advanced sensor/guidance system. Selection of a single type of TERM defines the command and control configuration to support the study, based on the limitations and capabilities of the ammunition.

Significance of the Study

Never in history has a U.S. tank possessed the capability to fire indirect ammunition. Additionally, U.S. tanks have never possessed precision (smart) ammunition within their arsenal. While the M1A1 and M1A2 are among the finest main battle tanks in the world, the pace of technology continually infringes on their superiority. Improved weapon systems, including the development and fielding of more lethal and longer ranging ATGMs, have introduced a significant threat that outranges the main gun firepower of the M1 series tank. TERM restores U.S. armor forces with standoff previously lost to ATGMs, as well as providing never before realized capability of on-board indirect precision fires.

Many would argue that this technological progression of gun to guided missile mirrors that of naval and aerial warfare. On the water, the age of the battleship, with its massive guns, is over. The seas are now ruled by an integration of aircraft carriers, cruisers, and submarines, each delivering its own systems and versions delivering guided missiles. In the air, the primary weapon of the fighter aircraft has shifted from machine

gun to the IR and radar-guided missile. In both cases, the direct fire gun system has been relegated to a backup or supporting role.[6] If the parallels hold true for ground forces, then tanks fighting with TERM are a natural progression of mounted warfare.

As the Army becomes a smaller and leaner force, forces require more lethality, less logistics, and greater survivability. TERM offers the promise of allowing fewer tanks the ability to mass greater firepower over an increased area of responsibility. Because of its high probability of hit and high probability of kill, TERM advertises logistics benefits by requiring fewer rounds to destroy more targets. Finally, the indirect standoff range of TERM promotes dispersion among units, as well as potential for decisively engaging the enemy outside the radius of his effective fires. These considerations weigh heavily toward preserving the force and enhancing battlefield survivability.

Implementation of Force XXI occurs daily. The EXFOR (4th Infantry Division) and the 1st Cavalry Division train regularly with digitized equipment, and the rest of the Army is not far behind. Along with Force XXI will come the fielding of TERM. The Army recently confirmed its commitment to fielding TERM for tanks. Picatinny Arsenal issued a request for proposals to industry in October of 1997. The request included a specification for TERM to cost from $20,000 to $30,000 per round, with a six-year contract to provide 24,000 rounds.[7]

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[6] Stanley C. Crist, "The M1A2 Abrams: The Last Main Battle Tank?" *Armor*, July-August 1997, 15.

[7] Seffers, 25.

TERM provides the company/team with never-before-realized standoff, flexibility, and combat power. Current fielding plans project TERM reaching the force as early as 2006. Concurrent with the new capabilities presented by TERM are inherent responsibilities for command and control, so far not specifically addressed by the current or emerging doctrine, tactics, techniques, and procedures. This thesis identifies, assesses, and synthesizes experimentation, experiences, and predictions to present a coherent recommendation for command and control of the armor company/team.

CHAPTER 2

REVIEW OF LITERATURE

The development of TERM is in its initial stages. Accordingly, significant works regarding specific command and control of units firing TERM are lacking. There are, however, several sources concerned with command and control for Force XXI.

Current doctrine serves as the baseline for Force XXI operations, including those with TERM. The FM 71 series outlines basic doctrine, tactics, techniques, and procedures at brigade, battalion, and company levels. These sources provide the starting point from which to explore to the possibilities of TERM.

Emerging doctrine serves to orient the progress and future of Force XXI operations and the use of TERM. Draft FM 100-5, *Operations*, outlines the emerging doctrine for the U.S. Army, while a series of supplementary material from the Armor Center at Fort Knox describes new or evolving doctrine, tactics, techniques, and procedures for the digitized force at the battalion, company, and platoon level. These sources further serve to orient the investigation of command and control of the company/team using TERM.

Major General Joe W. Rigby, Director, Army Digitization Office, and Major Mark D. Calvo have written an article about digitization with specific application to command and control. Their article describes some of the tools available for command and control in Force XXI. Additionally, Majors James C. Madigan and George E. Dodge of the Battle Command Battle Laboratory at Fort Leavenworth have written an article on the characteristics of commanders for Force XXI units. Their article effectively describes how commanders must think on the Force XXI battlefield. With this description,

command and control configurations can be designed as an extension of the commander's thoughts and priorities.

Lieutenant Colonel Robert R. Leohnard, former Chief of Plans and Exercises for the 4th Infantry Division (Mechanized), has written an article outlining a premise of fighting outnumbered and winning as part of operations for Force XXI. This article provides background into the general command and control issues associated with Force XXI initiatives.

The Field Artillery Community has written a series of articles regarding command and control in the Force XXI environment, among them are Majors Vince C. Weaver and Henry M. Hester, action officers for Task Force 2000, at Fort Sill, Oklahoma. Major General Randall L. Rigby, as the Chief of Field Artillery, has written about command and control of artillery fires. These articles are of special importance, as command and control of TERM may parallel that of the Army's primary indirect fire weapon--artillery. Additionally, there exists significant concern over the uninterrupted sensor-to-shooter links inherent in digitization. This automatic "see them--shoot them" trend in many ways preempts command and control and the commander's ability to influence the fight. This concern with automation that may circumvent the commander's influence also parallels considerations with TERM use.

The leadership of the Armor Community has published several articles outlining the future of mounted warfare. Successive commanders of the U.S. Army Armor Center, Major Generals Lon E. Maggart and George H. Harmeyer provided bimonthly updates in *Armor* magazine. Their articles provide valuable insights as to the prevailing attitudes, post-AWE conclusions, and a vision at the highest levels for the armor force.

Several recent works provide insight into digitization capabilities and drawbacks that directly relate to the command and control of a company/team using TERM. Michael D. Landers master's thesis, "A Proposed Battalion and Below Command and Control (B2C2) System Architecture for the Armor Battalion," provides an in-depth description and analysis of the command and control hardware and linkages of the Force XXI digitized unit.

The publications of leaders who have served within digitized units get to the heart of command and control issues at the battalion level and lower, providing excellent information and insight to the challenges presented in utilizing TERM at the company/team level. Two former Operations Officers of M1A2 tank battalions have written articles outlining their observations. Dean Nowowiejski, the Battalion Operations Officer (S3) of the first unit equipped with M1A2 tanks, has written an article candidly describing command and control shortcomings of the digitized systems of the M1A2. O. T. Edwards, another S3 of an M1A2 battalion, also has written an outstanding article describing his experiences on the digitized battlefield.

At the company and platoon level a significant works have emerged describing a variety of experiences and recommendations for the digitized force. Wade McVey, a former M1A2 tank company commander, and Daniel W. Peck and Robert S. Krenzel, former M1A2 tank platoon leaders and company executive officers, have written of their time in digitized units. They describe in great detail the tactical and technical aspects of the M1A2 company/team and platoon. They also discuss modifications to command and control to fully realize the potential of the tank company/team, many of which relate to TERM.

Leaders who have spent time observing and evaluating digitized units also provide input to command and control of the company/team using TERM. Dave Thompson, Timothy D. Cherry, and Jeffrey R. Witsken, former Observer Controllers (OCs) at the National Training Center (NTC) have written articles outlining their observations and recommendations for the digitized force. Additionally, Kevin D. Poling, former Chief of M1A2 Fielding to the Royal Saudi Land Forces, proposes solutions to resolve a series of issues encountered by the Saudi's digitized units, including those of command and control.

Two works from individuals not directly involved with digitized units also provide excellent insights on command and control. Mike Pryor, a former M1A1 tank company commander, published a mathematical analysis of a tank company/team using STAFF (Smart, Target Activated, Fire and Forget) ammunition, a precursor to TERM. His analysis of the battlefield framework suggests several command and control issues for a tank/company firing TERM. David C. Nilsen, a game designer for GDW games, has never served in the military, but his job requires intimate familiarity with weapons and tactics, as well as expertise in computers. From his unique perspective Nilsen provides several observations and recommendations regarding command and control of digitized forces.

Excellent background information exists from a series of briefings presented to senior Armor leadership at Fort Knox, Kentucky. Captain Charles Lipeles of the Directorate of Force Development, United States Army Armor Material Command (USAARMC), provided an excellent information brief an experiment on TERM using the JANUS simulation in 1996. Philip M. Donadio, from the Armament Research

Development and Engineering Center (ARDEC), provided detailed background information on the different munitions being considered for final selection as the M1A2 extended range tank round. Additionally, several representatives from the Armor Center's Training and Doctrine Command (TRADOC) division presented a briefing to all incoming Command and General Staff College (CGSC) Armor officers/students outlining proposed Force XXI task organizations, command and control structures, and fielding plans. The above briefings provided an excellent background for the development and fielding of TERM.

Specific works on TERM are limited. Of the works completed regarding TERM, none have specifically focused on the issues of command and control at the company/team level. Colonel John F. Kalb, Director, Directorate of Force Development at the Armor Center, and Lieutenant Colonel John Woznik, Armor Technology Manager, Army Research Laboratory (ARL), have both written articles outlining the capabilities and possible employment of TERM. Lieutenant Colonel Woznik's article provides a general overview of TERM and its capabilities. Colonel Kalb's article focuses on the employment of TERM in a uniquely organized task force, the Mounted Close Combat Battalion. Colonel Kalb's article gives significant insight into the capabilities and missions of a TERM-equipped unit.

The best source on TERM comes from the Mounted Maneuver Battlespace Laboratory (MMBL). Captain William Harris and Dr. Ken Hunt have spearheaded the simulation and evaluation effort on TERM. The Battlelab Experimentation Plan (BLEP) outlines the simulation and provides critical data on command and control organization and procedure. The simulation focused on five central issues. The first issue concerned

determining battalion/task for structure to optimize TERM. The second issue concerned evaluating tactics, techniques, and procedures to successfully utilize TERM. Third, the simulation sought to assess the command and control and situational awareness links to support TERM at the battalion/task force level. The fourth issue concerned determining a force structure to increase the survivability of reconnaissance elements. The final issue addressed configuration of tank basic loads in support of TERM.

The data provided from this experiment provides critical information for the analysis within this study. Properly manipulated and evaluated simulation results support assessment of the evaluation criteria of this study, essential to determining the best command and control configuration of the tank company/team.

CHAPTER 3

RESEARCH METHODOLOGY

General Overview

This study uses a two-step approach to answer the primary research question: How does the tank company/team command and control its forces to maximize the use of TERM? This approach assesses four primary aspects of command and control: organization, procedures, equipment, and personnel.

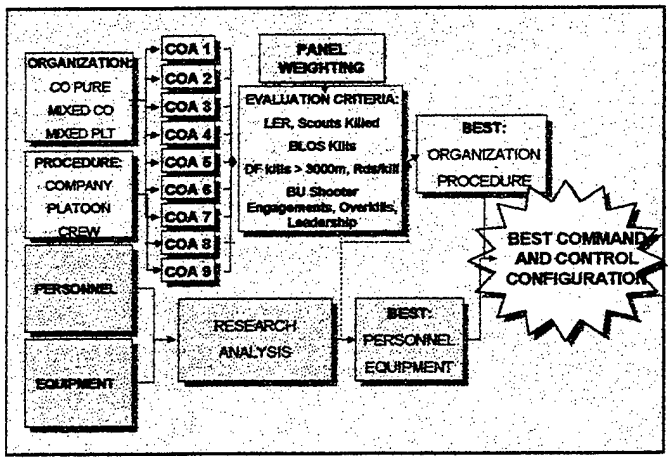

Figure 4. Research Methodology

First, this study uses a basic decision-making process to determine organization and a significant portion of procedures for a best command and control configuration. Second, this study analyzes available information to complete the look at procedures, as well as evaluating equipment and personnel for a best command and control configuration. The two different assessments, when combined, form the best overall

command and control configuration for the tank company/team using TERM (see figure 4).

Organization

In the first part of analysis, this study defines a set of possible command and control configurations, or courses of action, to apply to the basic decision-making process. Given these courses of action, this study assesses the different courses of action based on specific evaluation criteria. The criteria are also weighted according to a predetermined method. By comparing the different courses of action against the weighted criteria, a best command and control configuration for two specific areas is determined.

The courses of action selected for this analysis differ from the organization of the current tank company. The current tank company consists of three tank platoons of four M1A2 tanks each. The evaluated courses of action form a tank company of three tank platoons of three M1A2 tanks each. This organization was used by MMBL because of expected changes to the tank company from the division redesign. The differences between courses of action revolve around the organization of the scouts and the sensor-to-shooter pathways, not the number of tanks in a company.

The differing command and control configurations for this analysis are grouped around the areas of organization and procedures. For organization, three distinct options exist to form courses of action. The three organizations proceed from the least integration of scouts to the most integration of scouts within the company/team.

The first organization, tank pure (PURE), consists of courses of action where the organization of the company team does not change its current form of having no organic

scouts. Scouts are not integrated at the company/team level. The battalion controls a scout unit of eighteen Future Scout and Cavalry Systems (FSCS), controlling roughly six FSCS per company/team Area of Responsibility (AOR).

The second organization, mixed company (MIXED CO), consists of courses of action where the company team keeps its three tank platoons of three tanks each and adds a scout platoon of six FSCS. For these courses of action the integration of the scout platoon occurs at company/team level, where the company/team commander controls the scouts.

The third and final organization consists of a company team with mixed platoons (MIXED PLT), with tanks and scout vehicles within each of the three platoons. These courses of action result in maximum integration of scouts, with the platoon leader controlling the scouts.

In summary, organization determines control of the scouts and their FSCS. Under Pure, the battalion/task force controls the scouts. Under Mixed Company, the company/team commander controls the scouts. Under Mixed Platoon, the tank platoon leader controls the scouts. Each of the courses of action is defined by one of these three courses of action.

Procedure

For procedure, three distinct options exist varying according to the decision levels for the actual firing of TERM, from company/team to platoon leader to direct shooter level.

In the first procedure the company commander evaluates the target and designates which platoon will fire the TERM mission (CO). Once the platoon receives the order to fire, the platoon leader designates firing tank(s), and the shooter executes the mission.

With regard to the simulation, a time lag between target identification by the sensor and firing by the shooter represented the firing procedure. For this firing procedure, figure 5 indicates the architecture supported a time lag of 19.7 seconds. Additionally, if a backup firer is utilized, another 7.9 seconds is added for the mission to be handed off to an alternate tank/company team.

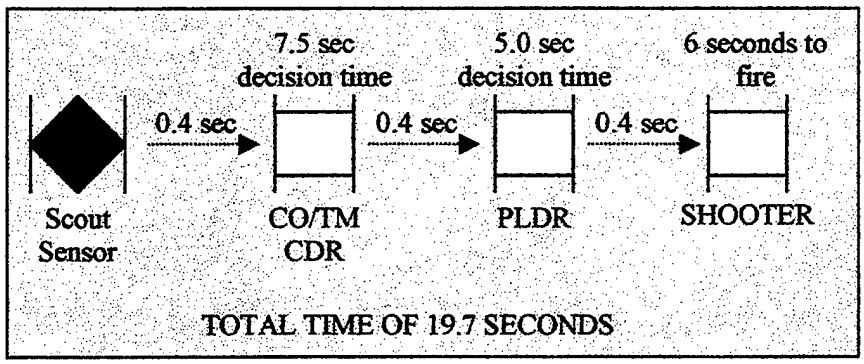

Figure 5. Decision Architecture for Company Fire Procedures

For the second procedure a platoon is designated as the firing unit for a particular scout element, with the platoon leader deciding whether or not to fire the mission (PLT). Once the decision to fire TERM is made, the platoon leader designates a section to fire the mission. The section wingman fires the mission, with the section leader as the alternate. The total time lag between sensor and shooter is shortened to 11.8 seconds. A time penalty of 5.4 seconds is applied if the mission is passed to an alternate tank platoon.

For the third and final procedure the decision for firing TERM is at its lowest level. For each scout element a sensor-to-shooter link is established between specific scouts and specific tanks (S-S). Tanks not assigned a specific sensor-to-shooter link serve as alternate firers. The tank commander of the designated tank decides whether or not to fire the TERM mission. Once the decision is made to fire, the tank commander fires the TERM mission for his assigned scout element, while another tank serves as an alternate. The time to fire during this firing procedure is 6.4 seconds, with an addition of .4 seconds if the mission is handed off to an alternate firer.

Courses Of Action and Evaluation Criteria

Courses of action for the decision-making process are formed from the aspects of organization and procedure, each with its own options. The logical set of courses of actions is shown in figure 6.

ORGANIZATION			
PURE	COA 1	COA 2	COA 3
MIXED CO	COA 4	COA 5	COA 6
MIXED PLT	COA 7	COA 8	COA 9
PROCEDURE	*CO*	*PLT*	*S-S*

Figure 6. Courses of Action

Each of the nine courses of action is assessed against a set of evaluation criteria. Criteria, initially described in chapter 1, are further defined as needed to provide a basis for analysis in the next chapter. The evaluation criteria are LER, percentage of scouts

destroyed, percentage of kills beyond line of sight, percentage of direct fire kills beyond 3,000 meters, average rounds fired per kill, frequency of backup-shooter engagements, percentage of overkills, and leadership. These criteria provide a form of measurement for evaluating command and control according to Army doctrine. The criteria utilized for this study apply to the dynamics of combat power - Maneuver, Firepower, Protection, and Leadership, as outlined in FM 100-5, *Operations*. This study also uses the tenet of army operations of synchronization. The above doctrinal concepts play a critical role in command and control at the company/team level.

The first dynamic of combat power is Maneuver. "Maneuver is the movement of combat forces to gain positional advantage, usually in order to deliver–or threaten to delivery of–direct and indirect fires. Maneuver is the means of positioning forces at decisive points to achieve surprise, psychological shock, physical momentum, massed effects, and moral dominance. Successful maneuver requires anticipation and mental agility."[8] Command and control configurations which allow the commander to retain freedom of movement, rapidly reposition forces on the battlefield, and provide situational awareness to anticipate and act have the advantage of Maneuver.

This study assesses maneuver according to three different measures. The first measure, frequency of backup-shooter engagements, is the average number of times an alternate shooter fired the TERM mission to engage the target. A high frequency of backup-shooter engagements detracts from the unit's ability to maneuver. High frequency indicates an inefficient use of the sensor-to-shooter link, tying down two firing

[8] FM 100-5, *Operations*, 2-10.

tanks, platoons or companies (depending on who the target is handed off to) for one TERM mission, increasing the number of units "in contact," taking away from the commander's ability to maneuver forces. Positive measures of assessing maneuver are the percentage of kills by BLOS and direct fire kills beyond 3,000 meters. High percentages indicate a course of action's ability to engage and destroy the enemy from long ranges, preserving the tank company/team's freedom of maneuver through time and space.

Firepower is the second dynamic of combat power. "Firepower provides destructive force; it is essential in defeating the enemy's ability and will to fight. It is the amount of fire that may be delivered by a position, unit or weapon system. Firepower may be either direct or indirect."[9] Command and control configurations that allow the commander to mass his firepower have the advantage of firepower.

This study assesses firepower according to two different measures. The first measure, LER, provides an overall assessment of the course of action's effectiveness for firepower. A higher LER indicates that a course of action can destroy a higher number of enemy vehicles at a lower cost in friendly combat power. Another measure of firepower is the average rounds fired per kill. Average rounds fired per kill assesses the efficiency of a course of action in applying its firepower. A lower average rounds fired per kill indicates that a course of action takes relatively more advantage of potential Firepower.

Protection is the third dynamic of combat power. "Protection conserves the fighting potential of a force so that commanders can apply it at the decisive time and

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[9] FM 100-5, *Operations*, 2-10.

place."[10] The four components of Protection are Operational Security (OPSEC) and deception operations, keeping soldiers healthy, safety, and fratricide avoidance. Configurations that conserve the force and provide security have the advantage of protection.

This study assesses protection according to the most vulnerable element of friendly combat power--the scouts. Scouts are the most vulnerable because of their prolonged exposure to enemy direct fire and their relative light armor when compared to tanks. Scouts are critical to the firing of TERM as they provide the critical information to the tanks of acquiring and reporting the enemy to allow the fire of TERM. Protection is assessed by the percentage of scouts destroyed for a course of action. A higher percentage detracts from protection for a course of action, and visa versa.

Leadership is the fourth and final dynamic of combat power. "The most essential dynamic of combat power *is competent and confident officer and noncommissioned officer leadership.* Leaders inspire soldiers with the will to win."[11] Configurations that maximize the opportunities for leaders to provide direction and motivation at the decisive point on the battlefield receive the highest ratings for leadership. This study assesses leadership according to a course of action's ability to allow the company/team commander to influence the battle. For effective leadership, the commander masses fires and redirects combat power to defeat the enemy. Factors assessed include the commander's ability to employ a reserve and his ability to influence the sensor-to-shooter

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[10] FM 100-5, *Operations*, 2-10.

[11] FM 100-5, *Operations*, 2-11.

linkage. A course of action's potential for leadership will be measured according to its unique organizational and procedural aspects. By organization, courses of action will receive a score based on the level at which scouts are organized, with a lower score being better. Battalion control of scouts (COAs 1 – 3) receives one point, company control (COAs 4 – 6) two points, and platoon control (COAs 7 – 9) three points. In addition, scores will be assessed according to the company commander's ability to influence TERM firing. Company fire control will receive one point (COAs 1, 4, 7), Platoon fire control two points (COAs 2, 5, 8), and sensor-to-shooter will receive three points (COAs 3, 6, 9). The scores of each course of action for its organization and procedure are summed to provide an overall leadership assessment, with less being better. Courses of action with lower sum totals perform relatively better in the criterion of leadership.

Synchronization is the third tenet of Army operations, critical to effective command and control. "Synchronization is arranging activities in time and space to mass at the decisive point."[12] Command and control configurations must integrate all elements of the Battlefield Operating Systems to achieve mass at the decisive point. Courses of action that integrate the Battlefield Operating Systems to achieve mass have the advantage of synchronization.

This study assesses synchronization according to the course of action's ability to efficiently use available fires. Percentage of overkills provides a measure of a course of action's Synchronization ability. Percentage of overkills indicates a course of action's inability to efficiently arrange activities in time and space. A high percentage of overkills indicates poor synchronization by a course of action.

Each evaluation criterion, once assessed, receives an assigned relative weight as part of the decision-making process. A board composed of tactical experts, met to assign relative weights for each criterion. The board contained an aviator (Apache pilot), three former Fire Support Officers, two former tank company or cavalry troop commanders, two former infantry company commanders (one mechanized and one light infantry), and one former battalion intelligence officer (S2). The group, briefed on the TERM concept and the intent of this study, determined the relative weights of each of the evaluation criterion. With the evaluation criteria weighted, a final analysis is made of the courses of action, with a best form of organization, and a significant portion of procedure selected.

Personnel, Equipment, and More Procedure

The remaining aspects of a command and control configuration, personnel, equipment, and the rest of procedure, are evaluated in a subjective manner. The evaluation is based on research of task force, company, and platoon level analyses of command and control of the digitized force. Army Warfighting Experiments (AWEs), and writings from M1A2 battalion commanders, operations officers, executive officers, platoon leaders, and company commanders provide the input to the final assessment of personnel, equipment, and procedure for this study.

Combining the decision-making process, which provides the optimal form of organization and procedure, with an analysis of personnel and equipment results in an overall optimal command and control configuration. This combination completes the analysis, answering the primary research question: How does the tank company/team command and control its forces to maximize the use of TERM?

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[12] FM 100-5, *Operations*, 2-8.

CHAPTER 4

ANALYSIS

General Findings from Simulations

Comparison Between Evaluated COAs and Baseline Configuration

The simulations conducted by the Mounted Maneuver Battlespace Lab (MMBL) in the spring of 1997 provide several insights on the use of TERM. These simulations indicate noticeable differences from current tank weapons and organizations. Additionally, simulations exhibit several trends along organizational, command and control, and numbers of different types of equipment and ammunition.

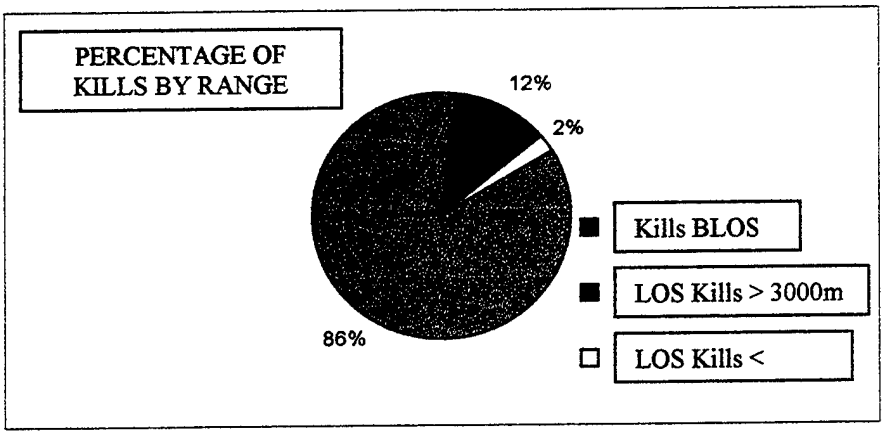

Figure 7. Average Percentage of Kills by Range of the Nine COAs Evaluated

Currently, M1A1 and M1A2 tanks destroy one hundred percent of their targets with direct fire out to 3,000 meters (LOS kills at less than 3,000 meters). The implementation of TERM drastically reduces the amount of direct fire "killing," as seen in figure 7.

TERM allows the tank company/team to make the vast majority of kills (eighty six percent) from standoff range and a significant amount of kills at an extended direct fire range (twelve percent). Only a very small percentage (two percent) of killing is done at traditional distances.

The MMBL used as a baseline the current tank organization (four tank companies, fourteen tanks per company, and a battalion scout platoon of six vehicles) equipped with TERM. In comparing this baseline with the COAs selected, differences with killing percentages remain, as seen in figure 8.

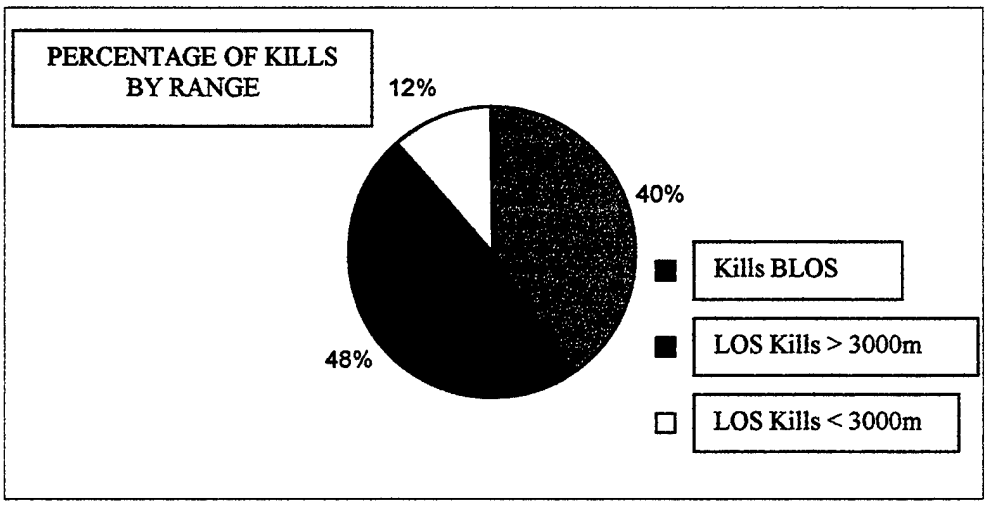

Figure 8. Percentage of Kills by Range for Baseline Organization

Compared to the baseline organization, the evaluated COAs provided nearly twice the killing at standoff (eighty-six versus forty eight percent) with resulting lower killing percentages at extended direct fire (twelve versus forty percent) and traditional direct fire ranges (two versus twelve percent). Clearly, the evaluated COAs allowed the tank company/team to destroy a higher percentage of the enemy at standoff ranges. This

phenomenal shift in killing, from one hundred to two percent at direct fire ranges, marks a significant shift in the maneuver and fires for the tank company/team.

With the introduction of TERM, M1A2 tanks conduct the vast majority of their killing out of range of the enemy's weapons. Without the danger of being killed by the enemy's direct fire, the tank company/team's survivability is greatly enhanced. Increased survivability and extended engagement ranges combine to enable the tank company/team to destroy the enemy at unprecedented kill ratios. The expected enemy-to-friendly loss ratio (Loss Exchange Ratio--LER) improvements are shown in figure 9.

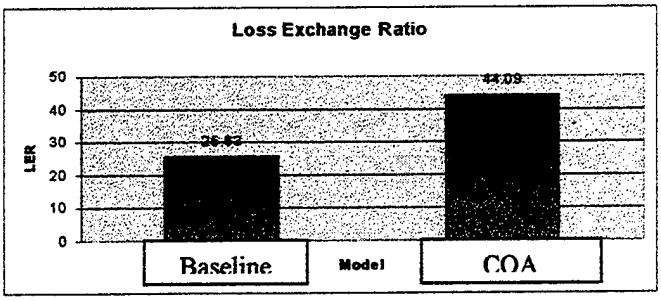

Figure 9. LER Comparison Between Baseline Organization and COAs

The significance in killing from extended range correlates to nearly doubled enemy-to-friendly kill ratios. TERM, by allowing the tank company team to fight with standoff, provides the force with increased killing power and higher survivability.

The increase in LER comes with a price. Compared with the baseline configuration, the evaluated COAs show a marked increase in rounds per kill and overkills, as shown in figure 10. The increase in rounds per kill and overkill indicate an increase in ammunition consumption for a tank company/team.

The success of BLOS fires relies heavily on the FSCS and the scouts' ability to identify and hand-off targets to the TERM firing tanks. With the significant increase in BLOS fires with TERM, one expects a decrease in the survivability of the FSCS and the scouts supporting this "deep" battle.

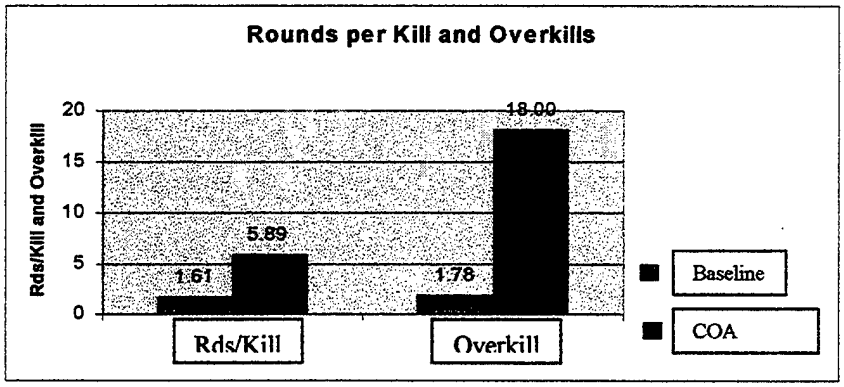

Figure 10. Average Rounds per Kill and Overkill for Baseline vs. COAs

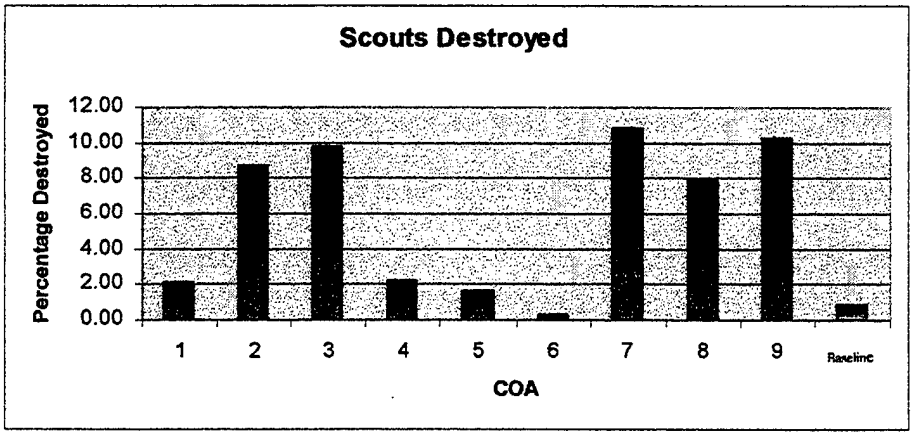

Figure 11. Scouts Destroyed for Baseline and COAs

As shown in figure 11, the COAs exhibit the expected increase in scout losses (up to 11 times) compared to the baseline, except for COA 6.

TERM clearly provides the tank company/team the ability to destroy the enemy at extended ranges. With approximately ninety eight percent of the killing done by TERM at BLOS and extended direct fire ranges, COAs with more TERM should have fared better. Simulations bear out this hypothesis with regard to LER (see figure 12).

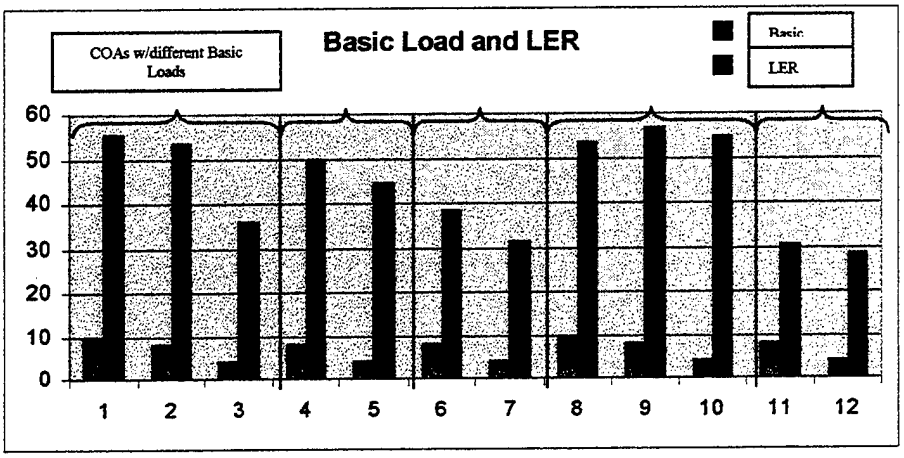

Figure 12. Basic Load and Effects on LER

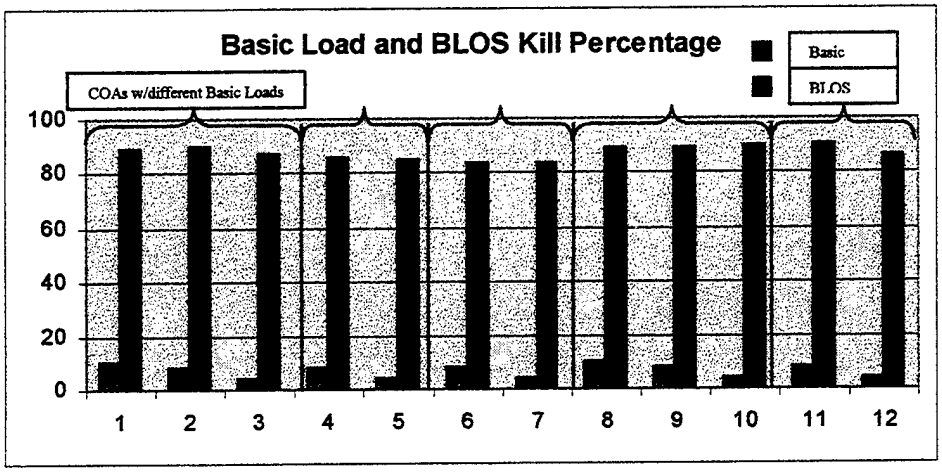

Figure 13. Basic Load and Effects on BLOS Kills

Similarly, with an increased basic load of TERM, tank companies/teams increased their killing at BLOS ranges, as shown in figure 13.

Simulations indicate that increases in basic load of TERM increases kill ratios through increased BLOS fires. Logically, the more TERM, the lower the rounds per kill, as shown in figure 14.

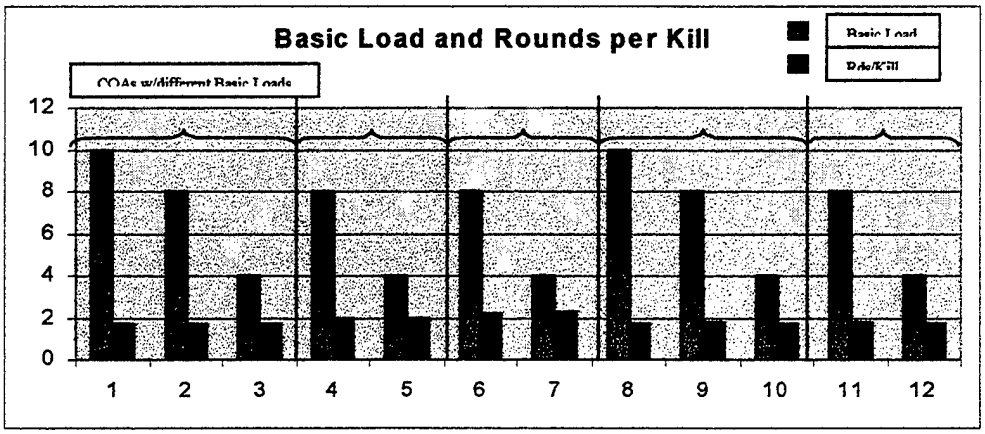

Figure 14. Basic Load and Rounds per Kill

Based on simulations, the size of the basic load of TERM exhibited no trends with regard to scout destruction or overkill.

A cursory look at changes in the Probability of Kill (Pk) for TERM produced expected results. An increase in Pk produced a resultant increase in LER and BLOS kills. Increased Pk also resulted in a decrease in rounds fired per kill and overkills. Changes in Pk produced no discernable trend with regard to scout survivability.

In summary, a general overview of the results indicates several trends. First of all, the use of TERM markedly changes the way tanks kill the enemy. Instead of destroying the enemy with accurate direct fires at ranges less than 3,000 meters, tanks are accomplishing the majority of their killing at BLOS ranges. The ability of tanks to kill with TERM at BLOS ranges increases their survivability, allowing them to kill at nearly

twice the LER as before. Increasing the amount of TERM basic loads has the expected effect: more TERM leads to a higher BLOS kills, higher LER, and lower rounds per kill average. TERM's ability to increase killing power, however, pays a price in increased percentage of overkills and a higher percentage of scouts destroyed.

Comparison Between Evaluated COAs

Several trends appear with regard to organization and command and control (C2). Significant differences exist between the three organizations of company, mixed company, and mixed platoon.

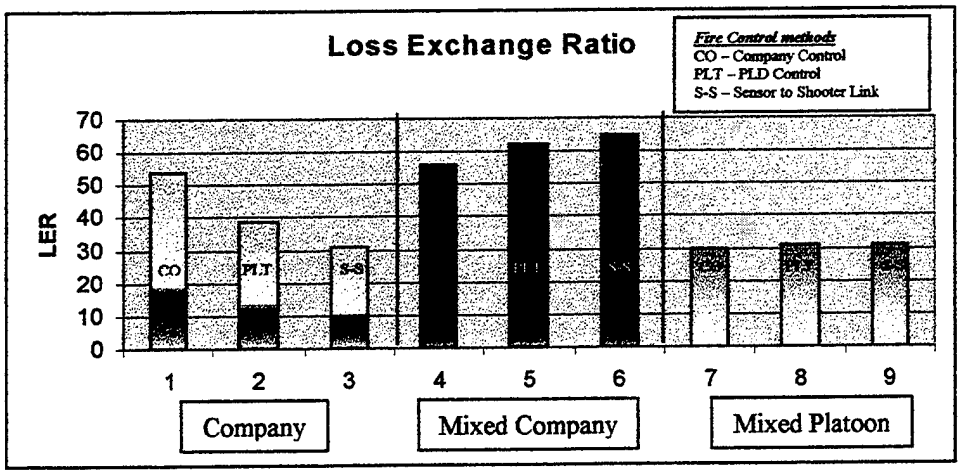

Figure 15. LER, Organization, and Fire Control

LERs exhibit clear differences between organization and C2 structures. As seen in figure 15, the mixed company (COAs 4-6) provides by far the best organization for maximum LER, followed by the pure company (COAs 1-3) and the mixed platoon (COAs 7-9).

With the battalion controlling scout maneuver (COAs 1-3), killing decreases as fire control is delegated lower. Apparently, with the battalion controlling maneuver of several companies, as well as coordinating the Battlefield Operating Systems, the company commander is best able to integrate BLOS fires with TERM into the fight. The company commander may be best able because of his direct link with the battalion commander and the battalion fight, his tactical experience, and his directly nested plan with battalion. By directly controlling the company's TERM fires, the unit is best able to contribute to the overall plan and provide the most killing power. As shown above, as fire control moves down the company chain of command (to platoon leader and shooter), the use of TERM has a less significant impact on the battle and a lower LER.

With platoon control of scout maneuver, fire control does not appreciably affect killing potential, and performs worst compared to battalion and company control of scouts. A reasonable explanation may center on the experience level and tactical expertise of the platoon leader. The use of TERM requires the leader to understand clearly and to apply (sometimes simultaneously) the concepts of close and deep battle, security, and synchronization. With platoon control of scouts, the platoon leader must optimize the above concepts while maneuvering his platoon, all within his commander's intent. These demands far exceed the expectations of platoon leaders, and it comes as no surprise that LER suffers under platoon control of scout maneuver. Additionally, with scouts organized at platoon level, platoons maintain responsibility for their own Area of Operations (AO). With each platoon maintaining its own piece of the fight, it becomes difficult for higher levels of command to mass fires at a decisive point.

With the company controlling scout maneuver (COAs 4-6), the more direct the fire control between sensor and shooter, the better. At the company level, leaders can expect tank commanders to be intimately familiar with the company fire and maneuver plan and their roles in it. Such individual clarity of purpose is not expectant between tank commanders and the battalion's maneuver and fire plan. At the company level, increased layers of fire control seem to inhibit effectiveness of TERM. Apparently, the faster TERM can be fired, the more effective the unit is with respect to LER. It stands to reason that if subordinate leaders understand the plan, then added levels of supervision only serve to hinder the process. A well-trained company/team, with an integrated fire plan, possess the best organization to optimize kill ratios when using TERM.

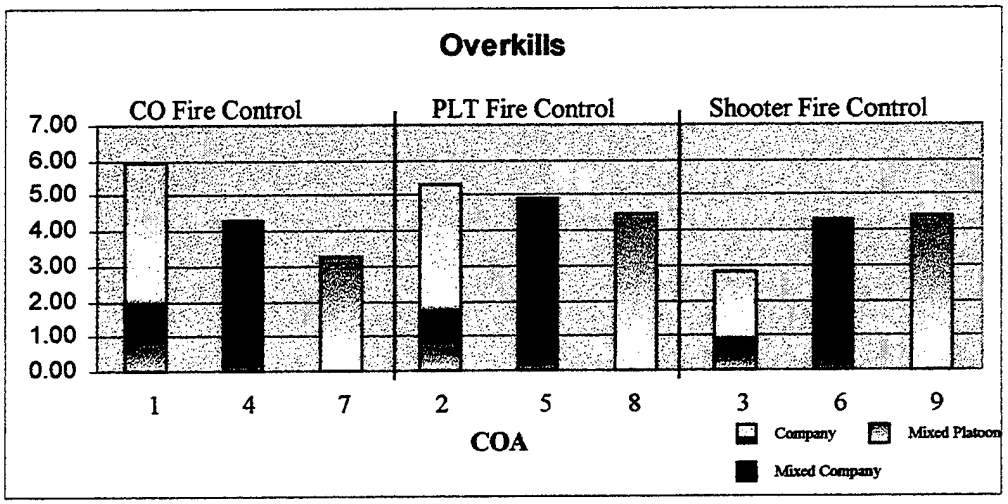

Figure 16. Overkills, Organization, and Fire Control

In addition to LER, an assessment of the percentage of overkills (in percentage of redundant hits) provides additional insights. In this case, if COAs are viewed according to fire control methods, different trends appear (see figure 16).

At levels of company and platoon fire control, overkill decreases as organizations become more decentralized. In a positive sense, overkill may be viewed as a measure of mass. If a unit masses fires at a location, a resultant increase in overkill occurs as multiple weapon systems acquire and fire into a "kill zone." While possibly viewed in a negative aspect in terms of efficient use of ammunition, the synergistic effect of massed fires provides killing effects that far outweigh the increase in overkills. Logically, as the level of scout control decreases from battalion to company to platoon level, units lose the ability to direct TERM fires to mass at a specific time and point in the battlefield. Previous evidence already shows that the majority of killing takes place at BLOS ranges. At these ranges scouts perform target acquisition. As commanders lose the ability to maneuver and mass their scouts on the battlefield, so do they lose the ability to mass fires at BLOS ranges, and overkill is reduced.

At the sensor-to-shooter level of fire control, overkill tends to increase as decentralization of scout control occurs. Apparently, at this lowest level of fire control, the lower the control of scouts, the greater the ability to mass fires, with a resulting increase in overkills. The success of decentralized fire control indicates that massed fires will fail to occur much higher than at platoon level.

Along with LER and percentage of overkills, scout survivability varies by COA, with trends of its own. Percentage of scouts destroyed shows differences according to scout control and according to fire control relationships, as seen in figure 17.

Initially, figure 17 indicates that scout survivability suffers under the pure company organization and fares even worse under the mixed platoon configuration. A marked improvement in survivability occurs at the mixed company level of organization.

An explanation in the vast differences between survivability may again be a function of exceeded span of control at battalion level and lack of experience and expertise at platoon level. With the battalion controlling scout movement, their survivability may be at risk due to several other demands on the battalion headquarters' time, resources, and concentration. With several companies to maneuver, fires to coordinate, and BOS to manage, scout maneuver may exceed the battalion's span of control, with a resulting loss in scout survivability. This potential lack of attention is magnified as fire control is delegated down from company to platoon to shooter level. With higher leadership removed from the fire control linkages, a gap may exist in battle tracking of scout survivability. As a result, scouts are not maneuvered, and scouts (particularly in simulations), lacking the initiative to reposition, die.

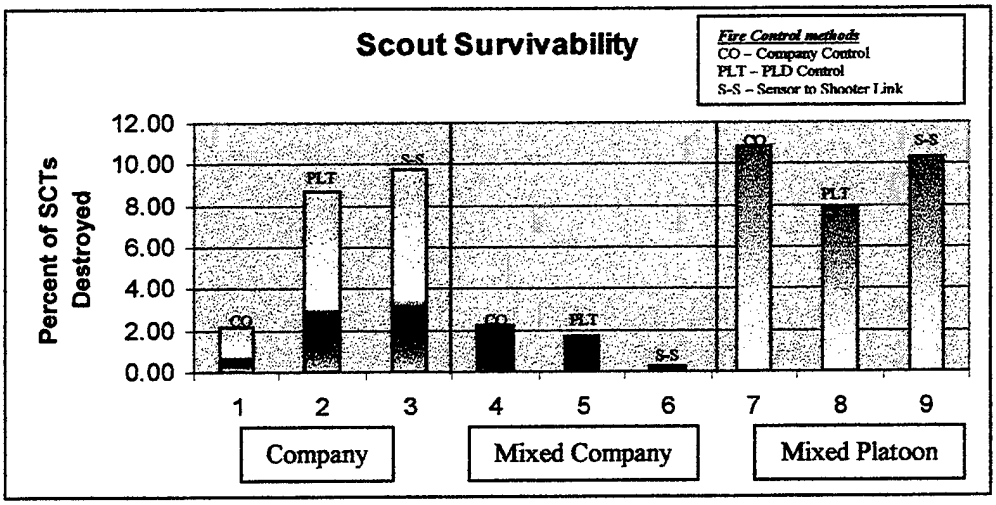

Figure 17. Scout Survivability, Organization, and Fire Control

At the platoon level of scout maneuver, scout survivability is worse than five times that at company control levels. A likely reason for high scout losses relates back to

the tank platoon leader's lack of experience and expertise in dealing with the extended battlefield framework (deep, close, security, etc.). Overwhelmed by his responsibilities, the platoon leader fails to properly position the scouts under his control, causing their deaths.

Company control of scouts promises the best survivability. A competent company commander and his XO seem capable of simultaneously maneuvering three M1A2/M2A2 platoons and an FSCS scout platoon. The company command group possesses the tactical acumen to maneuver these elements without exceeding its span of control. Interestingly enough, scout survivability increases as fire control is delegated from company to platoon to shooter level. This relationship directly relates to the increased LER from company to platoon to shooter level. Evidently, at the mixed company organization, added layers of fire control add time needed to kill a selected target, tending to inhibit killing capability. If it takes more time to kill an enemy vehicle, the enemy crew has to more time to maneuver and to destroy the acquiring scout vehicle, decreasing his chance for survivability. Therefore, the COA with a direct sensor-to-shooter linkup, under a mixed company organization fares the best--COA 6.

In summary, three significant trends appear across organizational and procedural lines. First of all with regard to LER, the mixed companies organizations perform the best, followed by pure companies and the mixed platoons. second, percentage of overkills decreases as fire control becomes decentralized. The least overkills exist when a direct sensor-to-shooter linkup exists. Overkills increase from platoon leader to company commander imposed fire control. Finally, scout survivability proves vastly superior at the mixed company organization. Percentage of scouts destroyed is larger at

pure company level and largest with the mixed platoon organization. These trends provide insight to the forthcoming analysis of courses of action against weighted decision criteria.

Course of Action Analysis

To determine the best course of action, an assessment against decision criteria occurs. The decision criteria, previously defined in chapter 1, and further discussed in chapter 4 as follows: LER, percentage of scouts destroyed, percentage of kills BLOS, percentage of direct fire kills beyond 3,000 meters, average rounds fired per kill, frequency of backup-shooter engagements, percentage of overkills, and leadership. A direct assessment of the nine courses of action against these criteria, weighted by a panel of experts, determines the best organization and a significant portion of the procedures for a best command and control configuration.

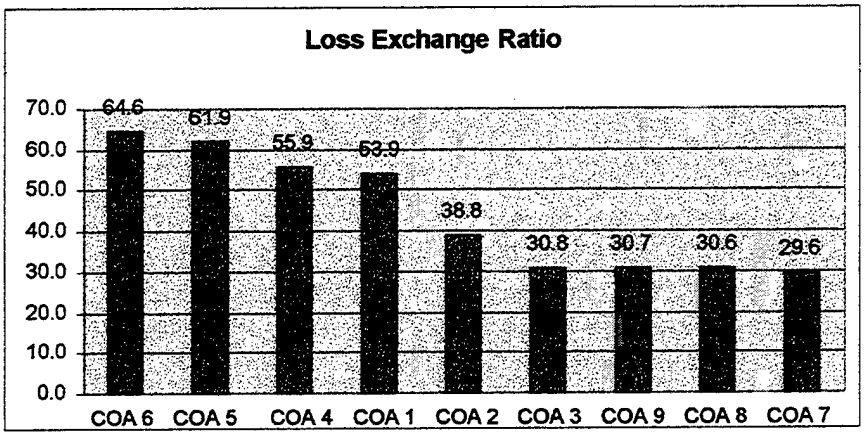

Figure 18. Ranking of COAs by Loss Exchange Ratio

An assessment of the courses of action against LER is shown in figure 18. As discussed previously, the Loss Exchange Ratio dominance of mixed companies (COAs 4

– 6) appears. The next highest organizational grouping of courses of action becomes pure companies (COAs 1-3), with mixed platoons (COAs 7-9) bringing up the rear.

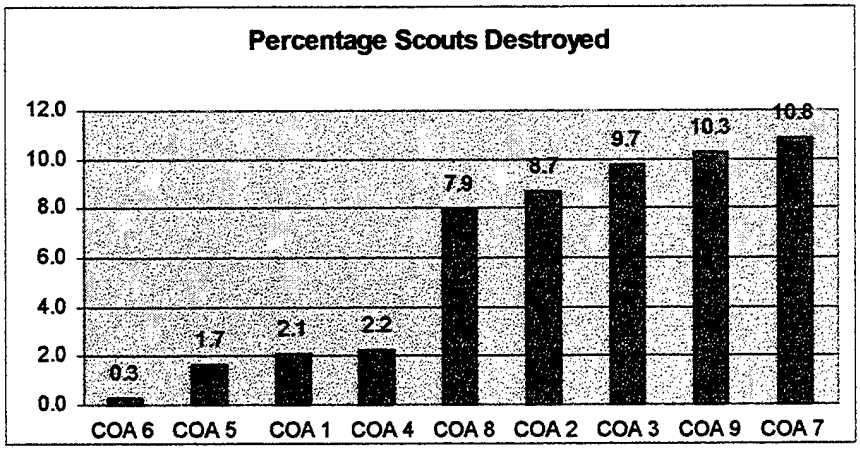

Figure 19. Ranking of COAs by Percentage of Scouts Destroyed

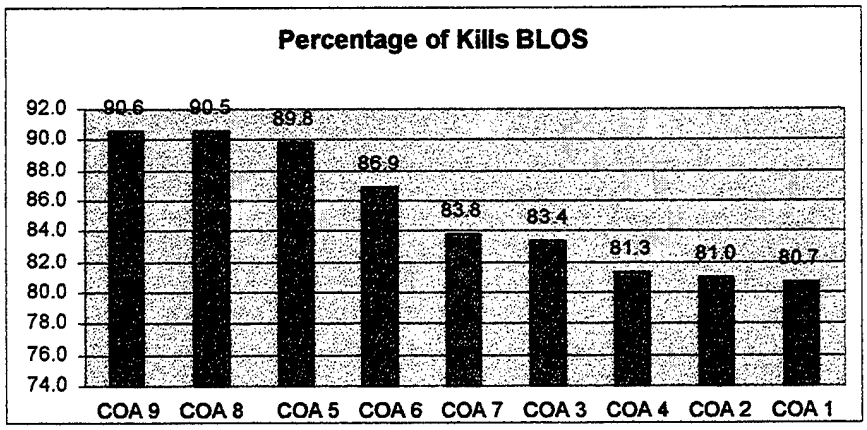

Figure 20. Ranking of COAs by Percentage of Kills BLOS

An assessment of the courses of action against percentage of kills by BLOS results are shown in figure 20. With regard to BLOS kills, mixed platoons perform the best, followed by mixed companies and pure companies. Interestingly, the pattern does not fall between fire control lines. One might expect to obtain more BLOS kills with

shorter fire control linkages, with the direct sensor-to-shooter relationship performing the best, followed by platoon fire control, then company fire control. This trend does not seem to be the case, however, as other variables seem to influence the outcome of BLOS kills.

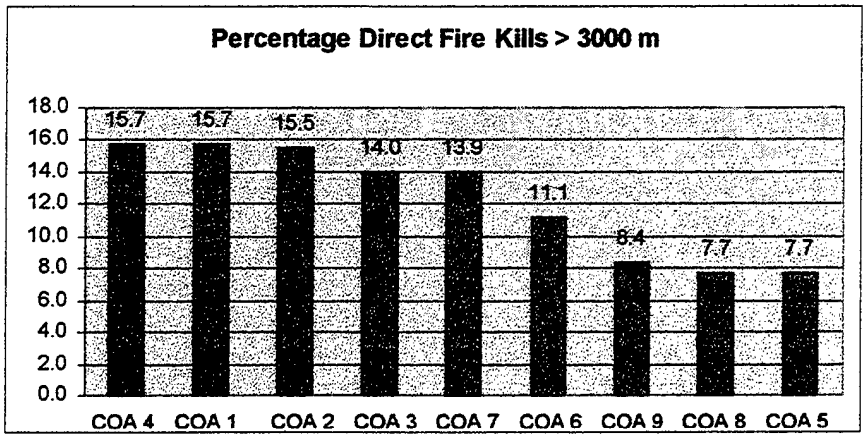

Figure 21. Ranking of COAs by Percentage of Direct Fire Kills > 3,000m

For direct fire kills beyond 3,000 meters, ranking occurs as seen in figure 21. No trends appear between organization and procedures for this criterion. Of significant note, however, is the relationship between TERM and the rankings. In looking at BLOS kills in figure 20, one can see that if a COA rated well with regard to BLOS kills, it rated worse with regard to Direct Fire Kills Beyond 3,000 meters, and visa versa. The overall importance of TERM become evident in that if a COA failed to kill the enemy at BLOS ranges with TERM, then it killed the enemy at ranges beyond 3,000 meters with TERM.

For average rounds fired per kill, the results are seen in figure 22. Again, no trends appear between organization and procedures. To estimate the significance of the difference between criteria requires a simple calculation. Assume that a tank company

team of eleven M1A2s each fires its basic load of ten rounds of TERM for a total of 110 rounds. If this common number is divided by the average rounds fired per kill, an average of kills results. This value varies from 63.9 kills for the best course of action to 59.5 kills for the worst course of action with regard to this criteria. The difference of destroying or not destroying approximately four enemy vehicles can certainly be regarded as significant, particularly at the company/team level.

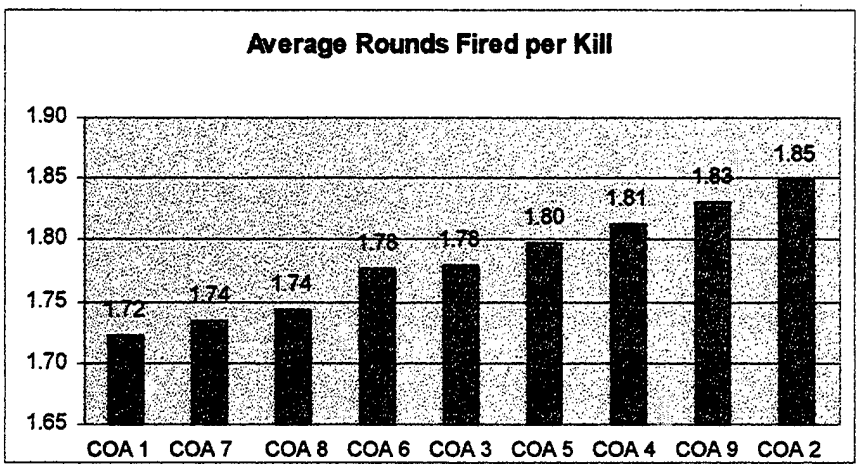

Figure 22. Ranking of COAs by Average Rounds Fired per Kill

For frequency of backup-shooter engagements, an assessment is seen in figure 23. While COAs seem somewhat grouped by organization (COAs 2 and 3, 4 and 5 and 6 and 8), COAs 7 and 1 do not fit a trend. Additionally, because data was unavailable for COA 9, trends are difficult to assess. Accordingly no trend appears between courses of action.

For percentage of overkills, the following assessment is made using figure 24. Again, no trends appear between courses of action. Additionally, there seems to be no

direct relationship between percentage of overkills and average rounds fired per kill making them, in fact, distinct criteria.

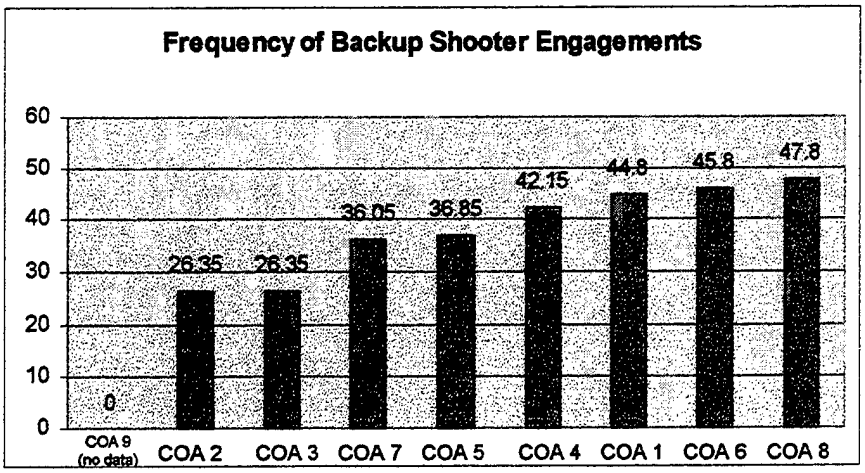

Figure 23. Ranking of COAs by Frequency of Backup-Shooter Engagements

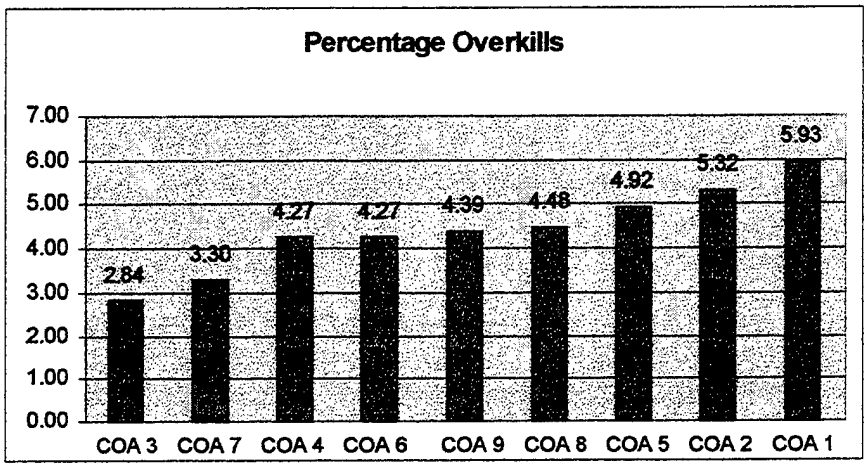

Figure 24. Ranking of COAs by Percentage of Overkills

For the final criterion, leadership, results are shown in figure 25. By design leadership favors centralized control of assets. This emphasis on centralized control

supports the intent of the leader being able to influence the battle through personal or electronic means.

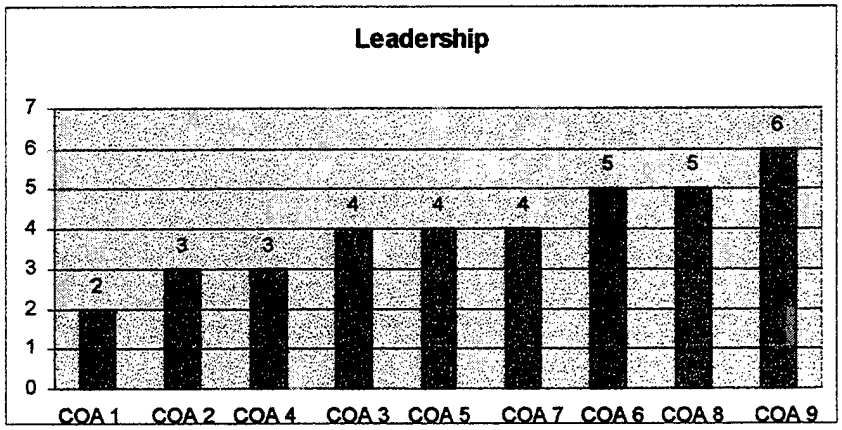

Figure 25. Ranking of COAs by Leadership

Table 1. Scoring of COAs Without Weighting

COA	LER	% Kills BLOS	% Scouts Destroyed	% DF Kills > 3000m	Ave Rounds per Kill	Leadership	Percentage Overkills	Backup Shooter Engagements	TOTALS
1	4	9	3	2	1	1	9	6	35
2	5	8	6	3	9	2.5	8	1.5	43
3	6	6	7	4	4.5	5	1	1.5	35
4	3	7	4	1	7	2.5	3.5	5	33
5	2	3	2	8.5	6	5	7	4	37.5
6	1	4	1	6	4.5	7.5	3.5	7	34.5
7	9	5	9	5	2	5	2	3	40
8	8	2	5	8.5	3	7.5	6	8	48
9	7	1	8	7	8	9	5	4.5	49.5

Course of Action Scoring

Given the previously discussed criteria, and scoring according to the "less is better" technique, the following assessment is shown in table 1.

The next step in the process involves weighting the different decision criteria. A panel of experts met on 10 February 1998 to determine appropriate weighting. The panel composed of nine officers-students of the 1998 Command and General Staff College (CGSC) course. The panel possessed a variety of skills, experiences, training, and education, allowing them to make an informed decision about the weighting of decision criteria (see annex A).

The panel grouped decision criteria into three groups from highest to lowest weighting. The first and most highly weighted group included LER, percentage of kills BLOS, and percentage of scouts destroyed. The panel weighted LER highly because the ultimate purpose of all weapons or ammunitions, including TERM, are to improve the force's ability to kill the enemy. Along those same lines, TERM must also minimize the enemy's ability to destroy friendly forces. As shown, the majority of the killing of the enemy takes place beyond direct fire range of the tanks, but within direct fire of the scouts, and the scouts. Additionally, the scouts are absolutely critical to the use of TERM, as they provide the targeting required for indirect fires. The panel decided that the critical friendly force to firing TERM, the scouts, must also receive high consideration. Accordingly percentage of scouts destroyed receives high weighting. The panel considered percentage of kills BLOS equally important based on the primary research question: How does the tank company/team command and control its forces to maximize the use of TERM? With TERM designed primarily as a BLOS weapon, percentage of kills BLOS directly addressed the maximum use of TERM and thus the primary research question.

The panel assessed percentage of direct fire kills beyond 3,000 meters and average rounds fired per kill with medium weighting. Percentage of direct fire kills beyond 3,000 meters received its weighting because the secondary purpose of TERM involved providing M1A1/M1A2 tanks extended direct fire range to overcome the standoff of enemy Antitank Guided Missiles (ATGMs). Average rounds fired per kill received similar importance because TERM, expensive precision munitions, must provide accurate lethal fires. Rounds fired per kill becomes equally important given the limited ready rounds of the M1A1/M1A2 (seventeen rounds), and the fact that any load of TERM replaces current HEAT and Sabot rounds.

Table 2. Scoring of COAs With Weighting

COA	LER (X3)	% Kills BLOS (X3)	% Scouts Destroyed (X3)	% DF Kills >3000m (X2)	Ave Rounds per Kill (X2)	Leadership	Percent Overkills	Backup Shooter Engagements	TOTALS
1	12	27	9	4	2	1	9	6	70
2	15	24	18	6	18	2.5	8	1.5	93
3	18	18	21	8	9	5	1	1.5	81.5
4	9	21	12	2	14	2.5	3.5	5	**69 – 3rd**
5	6	9	6	17	12	5	7	4	**66 – 2nd**
6	3	12	3	12	9	7.5	3.5	7	**57 – 1st**
7	27	15	27	10	4	5	2	3	93
8	24	6	15	17	6	7.5	6	8	89.5
9	21	3	24	14	16	9	5	4.5	96.5

The panel assessed the remaining criteria of leadership, frequency of backup-shooter engagements, and percentage of overkills with minimal weighting. Leadership,

though important to command and control, received minimal weighting because of the limited way to measure it. Frequency of backup-shooter engagement and percentage of overkills received minimal weighting because of their perceived indirect relationship to the command and control aspects of maximizing the use of TERM.

With the above weighing of criteria, the following assessment is shown in table 2. As indicated, COA 6, mixed company with sensor-to-shooter fire control results in the best course of action. Mixed company defines the best organization and sensor-to-shooter defines a significant aspect of procedure for the desired command and control configuration.

Procedure

> The task force commander does not gain an advantage over the enemy simply by using automated equipment, he achieves that advantage by using the information to position the soldiers and killing systems at the decisive point on the battlefield in a timely manner, to mass direct and indirect fires on the enemy, and synchronizing all seven battlefield operating systems.[13]
>
> *Tactics and Techniques for the Digitized Battalion Task Force*

The above excerpt from the Revised Draft ST 71-2-2, *Tactics and Techniques for the Digitized Battalion Task Force*, clearly identifies the need for command and control procedures to complement the fielding of improved equipment, including TERM. The previous analysis in this chapter identified an integral portion of the procedural aspect of command and control--the designation of a direct sensor-to-shooter linkup. This linkup,

however, is only a portion of the required procedures necessary to maximize the use of TERM.

Operation Desert Hammer VI (ODH VI), in 1994, involved the first NTC rotation of a digitized battalion task force. This task force contained over 120 digitized vehicles and systems, and although the use of TERM was not simulated, significant observations were made directly applying to command and control procedures of TERM at task force and company/team level.

An analysis of ODH VI showed that the digitized force had higher percentages of direct and indirect fire systems firing or participating in battles than non-digitized units. Larger numbers of indirect fire missions were requested and fired, but "battle outcomes were not decidedly superior to non-digitized units."[14] During some missions participation rates were high, but rounds fired and LER were low, as the unit piecemealed itself into the battle. During other missions, participation rates and rounds fired were high, and attrition warfare occurred on the battlefield.[15] While digitization and improved technology allowed superior situational awareness and improved killing capability, the task force and subordinate company/teams failed to translate their advantages into decisive victory. As stated by the task force's S3, Lieutenant Colonel Edwards, "Old

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[13] Revised Draft to U.S. Army Armor School, Special Text 71-2-2 *Tactics and Techniques for the Digitized Battalion Task Force*, (Fort Knox, KY, January 1995), 1-13.

[14] Jeffrey R. Witsken, "The Lessons of Operation Desert Hammer VI: Our Doctrine is Basically Sound," *Armor*, July-August 1995, 36.

[15] Witsken, 36.

tactics plus new systems equal the same results."[16] The task force's and company/teams' failure resulted from improper command and control procedures to direct fires at advantageous times, locations, and targets on the battlefield.

The challenge lies in implementing command and control procedures to prevent piecemealing or attrition, and instead direct fires toward decisive victory. Fortunately, current doctrine already exists at division and higher levels of command to control direct and indirect fires, establishing procedures to manage the close and deep battle. FM 6-20-10, *Tactics, Techniques, and Procedures for the Targeting Process* outlines a process to "help the commander to decide what to attack . . . how to acquire those targets, and when those targets are found, how to attack them."[17] While the company/team lacks the staff and assets to execute the deliberate targeting methodology specified in FM 6-20-10, fundamental aspects and basic procedures do apply. An economized and selective implementation of the methodology outlined in FM 6-20-10 provides procedures to prevent piecemeal and attrition battles.

The doctrinal targeting methodology, composed of the phases Decide, Detect, Deliver, and Assess, applies for the company/team. The commander must Decide what he wants to attack by developing a High-Payoff Target List (HPTL), supporting Priority Intelligence Requirements (PIR), and developing an Attack Guidance Matrix (AGM). The AGM, the final product of the Decide phase, provides the unit with specific

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[16] O. T. Edwards III, "Digital Battlefield Training and Insights of a User – The Good, The Bad, and The Ugly," *NTIS*, May-June 1995, 1.

[17] Headquarters, U.S. Department of the Army, FM 6-20-10, *Tactics, Techniques, and Procedures for the Targeting Process*, (Washington, DC, 8 May 1996), vii.

directions on which targets will be attacked, how, when, and the desired effects on the enemy.[18] A company/team AGM might look like table 3. The AGM prevents piecemeal and attrition warfare by outlining in time and space the destruction of those targets which will result in decisive victory.

Table 3. Example Company/Team Attack Guidance Matrix

HPTL	*WHEN*	*HOW*	*EFFECT*	*REMARKS*
CRP	A	TERM	D	1st PLT
FSE	A	TERM and FA Fires	D	1st, 2nd PLT
ADV GD – Mech COs	P	Direct Fires (TOW, 25 mm, Main Gun)	D	3rd PLT
Tank Company	P	TERM and CAS	D	2nd PLT
2S1s and 2S3s	P	FA Fires	N	
Breaching Assets	P	Direct Fires	D	1st PLT
2S6s	P	FA Fires	S	SEAD supports attack of Tank CO

WHEN – A: as acquired P: Planned I: Immediate
EFFECT – D: Destroy N: Neutralize S: Suppress

The Detect phase establishes the "who, what, when, and how for target acquisition."[19] The company/team commander directs his assets to establish situational

[18] FM 6-20-10, *Tactics, Techniques, Procedures for the Targeting Process*, 2-1.

[19] FM 6-20-10, *Tactics, Techniques, Procedures for the Targeting Process*, 2-10.

awareness within his unit's battlespace. To prevent piecemeal and attrition battles, the Detect phase provides the commander with a plan of observation to support the AGM.

The Deliver phase "executes the target attack guidance and supports the commander's battle plan once the HPTs have been located and identified."[20] The unit executes the AGM in this phase, modifying and adjusting the AGM as the battle unfolds.

The Assess phase "is the determination of the effectiveness of force during military operations."[21] The commander directs his assets to assess the effectiveness of the execution of the AGM, modifying the matrix based on weapons effectiveness, the changing tactical situation, and logistics considerations.

During the Deliver and Assess phases, the commander must have the ability to immediately influence the firing on targets, including TERM fires. This ability allows the him to modify the AGM during battle. The ability to stop and start TERM fires seems contrary to the direct sensor-to-shooter linkup selected in the COA analysis. "Analyses at the NTC and simulation gaming both indicate that the value of indirect fires increases as the response time decreases. The greatest improvements in fire support lethality may come from linking howitzers directly to observers, cutting out middlemen, and cutting the response time required for indirect fire to nearly the minimum–the projectiles time of flight . . . . The benefits of immediate fire support must be balanced against the benefits we gain from the massing of large numbers of cannon."[22]

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[20] FM 6-20-10, *Tactics, Techniques, Procedures for the Targeting Process*, 2-12.

[21] FM 6-20-10, *Tactics, Techniques, Procedures for the Targeting Process*, 2-14.

[22] Witsken, 37.

Establishing a sensor-to-commander-to-shooter relationship for indirect firing like TERM has tradeoffs.

One solution may strike a balance between the need to maintain a direct sensor-to-shooter relationship and allow the commander to direct massed fires as needed. The solution would be a "silence is consent" procedure for TERM fires. With the silence is consent procedure, the sensor-to-shooter relationship remains in place, but the commander retains the authority to disapprove a mission between sensor and shooter or redirect the shooter to another target, as he sees fit. The commander has the time it takes between target acquisition and TERM fires to impose his authority (6.4 seconds in the simulation), or he can suspend the current sensor-to-shooter relationship to establish another link between different sensors and shooters, supporting a critical location or time on the battlefield. "Silence is consent" allows the commander to act during the Deliver and Assess phases, without violating the proven sensor-to-shooter relationship.

The targeting methodology of Decide, Detect, Deliver, and Assess, modified to support the company/team, provide processes by which the commander can command and control the use of its assets, including TERM. The AGM provides the central product around which other aspects of the methodology support. Appropriate application of the targeting methodology prevents the piecemeal and attrition battle, allowing the company/team to achieve decisive victory. The modified targeting methodology, along with the silence is consent procedure fire control approach, provide the remaining aspects defining procedures for the best command and control configuration.

Equipment

An appropriate command and control configuration analysis includes an assessment of Equipment. Recent experiments and operations involving digitized forces indicate a need for additional equipment, as well as modified and improved use of equipment already on hand. This section addresses equipment modifications to support sustained digital communication, maintained situational awareness, command and control vehicles, and computer support for command and control. All of these considerations have significant implications with command and control as they relate to TERM.

Currently a single radio serves as both the voice and digital net for tactical operations at both the task force and company/team level. A recurring theme from senior leaders is the need for a dedicated digital net. Lieutenant Colonels O. T. Edwards III and Dean A. Nowowiejski, both having served as task force S3s of digitized forces, argue the case for separation between digital and voice traffic. Lieutenant Colonel Nowowiejski states "that during maneuver operations, many digital messages will never get sent because messages wait in queue until they expire . . . the best solution would be a separate digital net."[23] Lieutenant Colonel O. T. Edwards claims that "automated position updates emanating from moving tanks cause a near constant 'digital' chirping which, over time, becomes extremely annoying . . . [and] when a unit is in direct fire contact, FM voice remains the option of choice for contact reports, . . . a dedicated digital net would permit continued digital traffic flow."[24] The loss of digital information during

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[23] Dean A. Nowowiejski, "Achieving Digital Destruction: Challenges for the M1A2 Task Force," *NTIS*, January-February 1995, 3.

[24] Edwards, 1.

the battle degrades the purpose of digitized systems--improved situational awareness. This delayed delivery of digital messages, including target designations and TERM fire missions, seriously degrades the effectiveness of firing TERM. A clear need for a dedicated digital net is apparent. A dedicated net would preclude lost or delayed digital traffic, maintaining situational awareness and facilitating TERM fires.

An interesting and somewhat unsettling paradox for digitized forces occurs at the tactical level. As previously stated by Lieutenant Colonel O. T. Edwards above, when direct fire occurs, the unit switches from digital to voice contact. The change from digital to voice traffic indicates a contraction from an integrated digital situational awareness of the entire company/team's battlespace to an immediate situational awareness of each crew's eyes and vehicular sights. The paradox being that when units require their most comprehensive situational awareness, the system starts to break down. As a tank platoon leader and executive officer in an M1A2 company, Captain Robert Krenzel observed that tank commanders "prefer to be 'out of the hatch' where they can get a better panoramic view of their surroundings . . . this technique can be hazardous to one's health [and] it fails to take advantage of the M1A2's capabilities."[25] With tank and FSCS crews abandoning the advantages of their digitized systems, situational awareness of the company/team battlespace breaks down. The unit loses the ability to use TERM where it is most effective--at BLOS range.

Major Poling, in his observations as M1A2 Fielding Division Chief in Saudi Arabia, notes that the tank commander (TC) face *revolutionary* changes, while the rest of

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[25] Robert S. Krenzel, Jr., "The Armor Lieutenant and the M1A2," *Armor*, July-August 1995, 16.

the crew faces *evolutionary* changes in fighting the M1A2. He specifically cites the competing demands on the TC to simultaneously use the Commander's Independent Thermal Viewer (CITV), the IVIS, and fight his tank "locally" by knowing what was an immediate threat to his vehicle.[26] Consequently, when the TC moves from away from his CITV and IVIS screens to look outside the turret, and switches to voice communication to gain immediate awareness, both he and the company/team lose digital situational awareness. Lieutenant Colonel Dean Nowowiejski confirms this loss. His experience indicates that the company team loses the advantage of far target designation, creating digital contact reports, and digital calls for fire.[27] If we transfer this same effect to scouts in their FSCSs (loss of far target designation, contact reports and requests for fire), the company/team absolutely loses the ability to fire TERM in the BLOS mode. Additionally, tank crews, disregarding their digital systems, make themselves unavailable to fire TERM. David Nilsen asks, "Do we expect them to rapidly pop up and down like jack-in-the-boxes? Do we tell them to keep their hatches closed? . . . As fussy and fiddly as these details are, they are crucial if we actually expect people to use the system. We must make it easy and intuitive to use."[28] An equipment solution provides the most promise to alleviating this problem.

Several possible equipment modifications address the problem of integrating local awareness while promoting company/team situational awareness. Major Poling makes

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[26] Kevin D. Poling, "M1A2 Update: Training and Doctrine Observations From Saudi Arabian NET Training on the M1A2," *Armor*, May-June 1996, 17.

[27] Nowowiejski, 4.

mention of a Heads-up Display (HUD).[29] David Nilsen suggests an IVIS repeater or IVIS mount that can move in and out of the turret.[30] Major Tim Cherry, a former NTC OC, describes a "flat panel computer display that is movable and allows the vehicle commander to view the screen while fighting outside his turret."[31] No matter what the specific equipment, the underlying concept for any device must provide the TC or scout commander maintained situational awareness of the company/team battlespace.

With regard to the firing of TERM, the equipment must allow the TC to perform certain duties and maintain a minimal awareness. The equipment must enable the TC to designate a target for firing. In particular, vehicles/TCs must be able to designate targets digitally whether they are sitting in front of the IVIS or looking out of the hatch. This "in or out of the hatch" designation capability allows the tank to communicate digitally and update the situational awareness of the company/team, even while in contact. The equipment must also inform the TC that he has received an order to fire at a designated target, particularly TERM. This continuous notification ability allows the vehicle, and the company/team, to take advantage of a sustained and current digital situational awareness. Finally, the equipment must not degrade the TC's ability to maintain local awareness around his vehicle. He must maintain local security to preserve his crew and

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[28] David C. Nilsen, "What If?... How an IVIS-equipped M1A2 force Might have made a difference In twelve DESERT STORM incidents," *Armor*, May-June 1994, 34.

[29] Poling, 18.

[30] Nilsen, 34.

[31] Timothy D. Cherry, "Future Command-and-control Systems, IVIS and B2C2 Only Scratch The Surface," *Armor*, November-December 1994, 17-18.

the company/team's combat power. Equipment changes according to these standards promise maintained command and control for the company/team, and maximized use of TERM.

Increased battlespace at the company/team level, coupled with additional responsibilities for a deep and close fight, raise the equipment issue of whether the company/team leadership has or needs different command and control vehicles. With changes to the battlespace, can the company/team commander or his executive officer (XO) still perform duties from a tank?

There appears to be no inclination to remove the company/team commander from his combat vehicle. No one argues that the commander must be able to focus his unit at the decisive point on the battlefield by his own presence. He must be able to lead by example, maneuvering, attacking, and defending against the enemy as required. The commander must have a combat vehicle to perform this mission.[32] With the commander relegated to leading from a combat vehicle, the question becomes, can the XO still perform his duties from a tank?

A clear case can be made for an improved command and control vehicle (C2V) at the company/team level. Major Poling, from his observation of the Royal Saudi Land Forces equipped with M1A2s, argues that an improved C2V can efficiently send digital information higher and lower, as well as convert voice to digital format to send either higher and lower. The XO with a C2V minimizes the reporting and other administrative

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[32] Daniel W. Peck, "The Tank XO... 2IC or TOC-IC?" *Armor*, May-June 1997, 22.

duties for the commander, allowing him to fight the battle.[33] Minimizing distractions for the commander becomes increasingly important with the expanded battlespace of the company/team using TERM.

Major Poling's argument receives support from current cavalry troop organization and equipment. The cavalry troop of today fights within a battlespace similar to that expected of a company/team using TERM. In a cavalry troop, the XO works from an M577 (the current C2V), conducting the same battlefield coordination as stated above.

Current tank company/team doctrine, however, does not support a C2V for the XO. FM 71-2, *Tank and Mechanized Infantry Company Team*, includes as the duties of the XO receiving and consolidating reports, maintaining communications between the company/team and the task force TOC, and planning and supervising CSS.[34] An essential duty of the XO, however, is to serve as the "second in command . . . prepared to assume command of the company team as required."[35] In fact, FM 17-95, *Cavalry Operations*, similarly defines the cavalry troop XO's role, providing for his second in command duties by ensuring the troop XO is "assigned a combat vehicle so he can quickly assume command of the cavalry troop."[36] Apparently, the tank company/team XO's and the cavalry troop XO's duties have been the same. The difference revolved around equipment. While armor units mandated that the XO conduct battlespace

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[33] Poling, 19.

[34] Headquarters, U.S. Department of the Army, FM 71-1, *Tank and Mechanized Infantry Company Team*, (Washington, DC, 22 November 1988), 2-1.

[35] FM 71-1, *Tank and Mechanized Infantry Company Team*, 2-1.

management and second in command duties from a single combat vehicle, cavalry separated the duties according to a C2V and an "assigned" combat vehicle. From an economical and simplicity standpoint, the challenge arises as to whether the XO of a company/team firing TERM can perform all of his duties in a combat vehicle, or does he need a separate C2V and an assigned combat vehicle?

Captain Daniel Peck, in his article "The Tank CO... 2IC or TOC-IC?" vehemently argues that the XO must fight from an M1A2 tank. He goes on to describe the doctrinal functions of the XO and determines that the M1A2 meets the company's needs because the "company [commander] CAN see its [his] entire battlespace."[37] Because of this vision the company does not need a TOC – like configuration controlled by the XO to "paint the picture for the commander."[38] Captain Peck fails to consider, however, that the company/team battlespace expands greatly with the use of TERM and other Force XXI initiatives, and the company/team commander can no longer see his entire battlespace. The argument for a C2V seems justified, but perhaps equipment improvements can make the use of an M1A2 by the XO practical.

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[36] Headquarters, U.S. Department of the Army, FM 17-95, *Cavalry Operations*, (Washington, DC, 24 December 1996), 2-16.

[37] Peck, 23.

[38] Peck, 23.

Captain Dave Thompson, in his article "Company/Team Command Post: The Missing Link" rationally outlines the duties of a command post (CP). He defines them as follows:

1. Posting/maintaining a timeline.
2. Posting/maintaining unit status.
3. Recording and passing information.
4. Integrating attachments.
5. Posting the map.
6. Building sand tables.
7. Coordinating reproduction of overlays and orders.
8. Assist the 1SG and XO in coordinating for logistics support.[39]

Of these, numbers 2, 4, 7, and 8 are already supported by the IVIS system on the M1A2. A simple addition to the IVIS onboard the M1A2 would seem to solve number 1 (timeline), and number 6 (build sand tables) could be solved by assigning someone within the headquarters group (commander/XO tank crew, NBC NCO, etc.).

Numbers 3 and 5 would seem to be already supported by IVIS on the M1A2, but Captain Robert S. Krenzel, who served as an M1A2 tank company XO, indicated otherwise. As discussed, the lack of the digital net and loss of situational awareness from TCs looking out of their turrets during the battle results in a loss of traffic on the digital net. This breakdown of digital tactical awareness forced XOs to seek a point of observation and report only what they could see and hear from voice transmissions.[40] As previously discussed, this digital breakdown has dire consequences for a company team with expanded battlespace trying to fire TERM. Accordingly, equipment fixes already

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[39] Dave Thompson, "Company/Team Command Post: The Missing Link," *Armor*, July-August 1996, 37.

[40] Krenzel, 15.

discussed (dedicated digital net, HUD or situational awareness modifications) go a long way to having the M1A2 IVIS assist the XO in transferring messages, reports, and maintaining a map. Captain Krenzel makes the excellent observation that the XO performs his duties from a unique perspective, "almost holding himself in a sort of company reserve until the initial reporting requirements are met."[41] This technique fully supports the XO's duties as battle captain, allowing him to manage the company/team's expanded battlespace separately from the "fog of war", as argued by Captain Peck.[42]

The company/team XO does not need a vehicle different from his M1A2 to perform his command and control duties. Equipment and procedural modifications already discussed fully support the XO continuing to perform his current duties from an armored vehicle instead of a dedicated C2V.

The installation of an onboard computer system for the tank, focused on situational awareness, provides an excellent platform to augment the command and control of a company/team using TERM. Research indicates several improvements or replacements of current computer systems to improve the company/team's ability to command and control.

Major Timothy Cherry, in his article "Future Command and Control Systems, IVIS and B2C2 Only Scratch the Surface" provides several informed insights to taking advantage of the computational power of the M1A2. He makes several recommendations directly related to command and control of the company/team using TERM. Major

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[41] Krenzel, 15.

[42] Peck, 23.

Cherry supports modifications to M1A2 IVIS to make it similar to the NTC Instrumentation System (NTC-IS). This system provides near real-time feedback on position location, fire event pairing, indirect fire processing, map and graphic control measures.[43] The situational awareness of a system like NTC-IS provides the critical information required by a company/team firing TERM.

To support the Attack Guidance Matrix procedures discussed earlier in this chapter, the company/team must be able to determine what type of target has been identified (Detect), whether a fire mission has been assigned (Deliver), and the resulting status of the enemy after the attack (Assess). Major Cherry recommends a set of icon protocols to support situational awareness. The TCs and scout commanders should have the ability to select the appropriate enemy icon from a menu once a target has been designated. Firing vehicles have "vectors" projected from them to show in/direct fires, and "blackboxes" replace friendly and enemy destroyed vehicles. Major Cherry also proposes a coloring system to distinguish friendly from enemy, and templated from actual vehicles.[44]

User friendly free-text messaging and screen-type overlay production and modification, supported by the use of a free-draw light pen were improvements to IVIS cited by Lieutenant Colonels Nowowiejski and Edwards, as well as Major Cherry.[45] This capability enables the efficient use of digitally transmitted FRAGOs, as well as the execution of the "silence is consent" fire control procedure stated previously.

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[43] Cherry, 16.

[44] Cherry, 17.

Major Cherry proposes an extensive onboard map capability paired with a graphic symbology package from FM 101-5-1, *Operational Terms and Graphics.*[46] Lieutenant Colonel Nowowiejski confirms the need for improved graphical capabilities on the M1A2.[47] The addition of colored circles, rings, or spheres portraying weapons ranges and target acquisition capabilities for individual vehicles might prove useful for engagement area planning. Maps and appropriate symbology are essential to effective command and control. Geographical considerations for employment of TERM (ranges, limits of observation, dead space, etc.) necessitate a readily accessible system assisting in a comprehensive assessment of terrain and positioning for the company team.

The above-mentioned modifications and improvements begin to address the possible assistance that the onboard computer system can provide to the company/team. The digitized capabilities of the M1A2 provide the company/team the platform necessary to successfully command and control the use of TERM.

In summary, several equipment issues promise support of command and control using TERM. A dedicated digital net, equipment providing sustained situational awareness to the TC, the continued use of the M1A2 by the XO, and improvements to IVIS provide Equipment aspects to the best command and control configuration.

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[45] Nowowiejski, 1-2; Edwards, 3.; Cherry, 17.

[46] Cherry, 17.

[47] Nowowiejski, 1.

Personnel

The test of control is the ability of the leader to obtain the desired reaction from his command.[48]

Infantry in Battle, 1939

The best command and control configuration produces rapid, decisive reaction by the unit. The determination of a best command and control configuration for the company/team firing TERM includes an assessment of personnel. Does the company/team possess the right personnel, doing the right things, to achieve decisive victory on the battlefield?

The two primary personnel responsible for implementing command and control for the company/team are the commander and the XO. Doctrine provides that the commander focus his efforts towards the decisive point on the battlefield.[49] Previous analysis indicates that ninety-eight percent of the destruction of the enemy occurs at BLOS range, or the deep battle. It follows that the decisive point occurs within the deep battle. The deep battle, containing the decisive point on the battlefield, deserves the commander's focused efforts. The addition of a deep battle, combined with the commander's shift of focus to the deep battle, mark a significant change from previous company/team tactics. If the commander is immersed in the orchestration of his scouts, tanks, indirect fires, and such to achieve victory in the deep battle, who controls the two percent of the fighting that occurs at the close battle?

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[48] FM 17-95, *Cavalry Operations*, 2-1.

[49] Draft FM 100-5, *Operations*, 9-5.

With the expansion of the company/team's battlespace, and its delineation between close and deep, the XO position faces the prospect of assuming new responsibilities. While the commander focuses on the deep battle, command and control of the close battle logically falls to the XO. The XO is the only other person besides the commander who maintains the company/team perspective on the unit's battlespace and it's relation to task force maneuver. To allow the company commander to focus on the decisive deep battle the XO must assume the close fight. This added responsibility does not conflict with his current duties of battle tracking, reporting, and serving as the second in command. By assuming the close fight, the XO acts as he did in the past. He positions himself with the supporting effort (now the close fight instead of the support element), applying leadership and direction as needed, while remaining prepared to assume command of the entire company/team.

Another member of the command and control team, the Fire Support Officer (FSO), continues to serve with the company/team, but with a different focus. ODH VI witnessed the evolution of the role of the FSO. The FSO's traditional "primary task of executing critical fires shifted more toward managing sensors and coordinating fires."[50] Under the best command and control configuration, the scouts and tanks have direct digital sensor-to-shooter links with artillery-firing units. The FSO focuses on assisting the commander in planning and implementing the Attack Guidance Matrix and "silence is consent" concept as a proposed procedure, incorporating scouts, tanks, and TERM as indirect fire assets.

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[50] Vince C. Weaver, "Fires in AWE Focused Dispatch – A Step Toward Task Force XXI," *Field Artillery*, March-April 1996, 38.

Subordinate leaders also provide necessary command and control to the company/team. These leaders, the tank and scout platoon leaders, serve very much as they have in the past.

The scout platoon leader, under the proposed organization, works for the company/team instead of for the task force commander. The scouts face a fundamental change in their role on the battlefield. No longer tasked with just providing reconnaissance duties for the force, the scout platoon leader assumes the critical responsibility of maneuvering his platoon to bring decisive fires on the enemy. The scout platoon leader takes direction from his commander, maneuvering his assets to support the AGM to maximize TERM fires.

With the ability to provide indirect fires with TERM, the tank platoon leader now fights his platoon in one of two possible modes, the deep or the close fight. The tank platoon leader's primary function is to support decisive action in the deep fight. He monitors his platoon's fire missions and assigns and reassigns firing tanks to sensor-to-shooter links according to ammunition consumption, terrain limitations, TERM range, fratricide prevention, and so on. The tank platoon leader fights a close fight as directed by his commander, and as needed to ensure self-defense. With increased battlespace and situational awareness, platoon leaders cannot expect to maintain constant visual contact with their tanks. They may, in fact, find themselves widely dispersed to support long range TERM fires, rapidly concentrating to mass fires in the close fight. An increased level of tempo, and two different "fights," will force tank platoon leaders to rely on their platoons' training and expertise to maximize the capabilities of the M1A2.

In summary, several personnel aspects are critical to the best command and control configuration. The company/team commander assumes the deep fight while the XO controls the close. The FSO no longer executes critical indirect fires, but manages sensor-to-shooter linkages and clears fires according to the AGM. The scout platoon leader no longer provides only reconnaissance, but maneuvers his force to bring decisive fires on the enemy. Finally, the tank platoon leader fights his platoon in two distinct modes, the close and the deep. He commands and controls a dispersed platoon in the deep fight, using the digitized capabilities of his tanks and crews to rapidly react to close threats, with the intent of dispersing again to rejoin the deep fight. These aspects outline the personnel portion of the best command and control configuration.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Fundamental Conclusions

The purpose of this study is to determine how the tank company/team commands and controls its forces to maximize the use of TERM. A series of conclusions set the framework for the use of TERM, establishing the correct command and control configuration to maximize its use.

The first conclusion about the use of TERM is that a fundamental shift exists on how the company/team kills the enemy. Prior to TERM, the company/team killed virtually none of the enemy at BLOS ranges. Command and control focused on a "close" fight. With TERM, the company/team kills eighty-six percent of the enemy at BLOS ranges. Command and control must focuses on this "deep" fight to defeat the enemy.

The second conclusion about the use of TERM is that it vastly improves the killing capability of the tank company/team. By maximizing TERM the tank company/team can kill at least twice as effectively as before. Expanded killing capability increases the width and depth of a company/team's Area of Operations, and its resulting battlespace. Command and control must address the challenges to managing this increased battlespace.

The third conclusion, the need for increased situational awareness, follows from the first two. The ability to destroy the enemy at extended ranges along with increased battlespace combine to magnify the importance of situational awareness for the tank company/team. To kill the enemy at BLOS ranges and manage an expanded battlespace

the company/team requires forward positioned scouts interacting with TERM firing tanks. The sensor (scout) to shooter (tank) relationship becomes essential to maximizing TERM. As sensors, scouts assume a critical targeting mission. This mission expands their traditional role from reconnaissance and security to one of providing targeting data. Targeting data provides crucial input to the situational awareness, enabling the company/team to decisively engage the enemy. The linkage between scout and tank, and the commander's ability to monitor and influence this linkage, form the basis for situational awareness. Command and control necessarily includes responsibility for increased situational awareness.

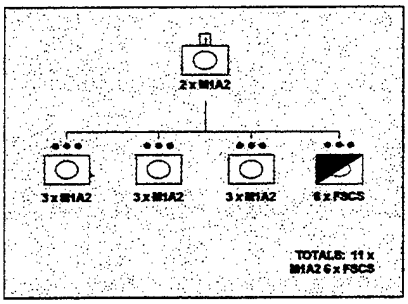

Figure 26. Tank Company/Team Organization

Organization

With command and control broken into four subelements: organization, procedure, equipment, and personnel; additional conclusions result. For organization, the best structure of the tank company/team includes company control of scouts (figure 29). Analysis indicates that company control is best because it provides the best killing efficiency (LER) for the company team and the best chances for scout survivability, while providing excellent killing at BLOS ranges. Company control of the scouts

provides the optimal organization for command and control of the company/team using TERM.

Procedure

Several procedures maximize command and control for the company/team. Analysis concludes that the optimal fire control relationship between scouts and tanks is a direct sensor-to-shooter linkage. Direct linkage minimizes the time to fire TERM, resulting in the optimal LER, scout survivability, and BLOS kills.

To impose the commander's will and intent on the use of TERM, the direct sensor-to-shooter relationship is modified to include a "silence is consent" procedure. "Silence is consent" allows the direct sensor-to-shooter relationship to exists, while allowing the commander to interrupt the process to react to changing battlefield conditions.

To further convey the commander's concept to concentrate TERM fires on decisive actions, the procedure of using an Attack Guidance Matrix (AGM) is adopted. This study concludes that by utilizing doctrinal targeting methodology, in the form of a modified AGM, the company/team can mass TERM fires at the decisive point.

The sensor-to-shooter relationship, "silence is consent," and AGM procedures provide essential command and control elements to maximize the use of TERM.

Equipment

As mentioned, situational awareness forms an essential aspect of command and control for the company/team using TERM. Unfortunately, simulations indicate that situational awareness actually declines during combat. Equipment modifications provide

essential command and control components to reinforce situational awareness for the company/team.

The first equipment modification requires the addition of a dedicated digital net for the company/team. The dedicated net provides the necessary communication link between members of the company/team to ensure situational awareness within the unit.

This study identified the conflict for the tank and scout commander to man his digital systems contained within his vehicle while fighting his vehicle "out of hatch" against close-in enemy within direct fire range. A clear need was identified to provide the tank and scout commander with "out of hatch" enhancements which allowed him to maintain both local and digital situational awareness during the fight. Equipment modification for "out of hatch" enhancements include the addition of an out of turret IVIS extension for the tank or scout commander, an external target designation device, and TERM mission notification.

Within the turret, additional modifications are necessary to enhance the digital capabilities and situational awareness of the tank company/team. These enhancements focus on the IVIS. Proposed modifications to the IVIS include NTCIS presentation, icon protocols, free-text messaging, and a light pen. These modifications promise to make the use of digital systems and reporting easier for the tank and scout commander, sustaining situational awareness for the tank company/team, particularly during combat.

An additional consideration, that of putting the executive officer into a dedicated command and control vehicle (C2V), was analyzed. This study concludes that organizational, procedural, and equipment changes preclude the use of a C2V by the executive officer. The current location of the executive in a tank provides necessary

sustained situational awareness. By sustaining situational awareness through all phases of the battle the company/team maintains command and control to maximize the use of TERM.

Personnel

The final subelement of command and control--personnel, addresses the increase of the company/team's battlespace and extended range fires.

With the company/team fighting both deep and close, analysis concludes that the close and deep fights be divided between the commander and the executive officer. Since the majority of killing occurs at extended ranges, the company/team commander assumes responsibility for the deep battle. Likewise, the executive officer fights the close battle.

Additionally, changes to the battlefield, particularly the emerging relationship between scouts and tanks, results in a new focus for the company Fire Support Officer (FSO). Analysis suggests that sensor-to-shooter relationships should exist between artillery and observer as well as scout to tank. The logical conclusion becomes that the FSO participate in the "silence is consent" procedure like the commander, clearing indirect fires for the company/team according to the AGM.

Summary

In summary, the conclusions presented in this study form sound basis for command and control of the tank company/team attempting to maximize the use of TERM. TERM impacts the company/team through increased lethality, increased battlespace, and the need for enhanced situational awareness. These impacts combine to

set conditions for an appropriate command and control system defined by the subelements of organization, procedure, equipment, and personnel.

Recommendations

The introduction of TERM to the U.S. Army promises transformation of the way the tank company/team fights and wins on the battlefield. This transformation presents far-reaching impacts across all elements of the Army. This study recommends several issues and topics for study not addressed by this thesis.

Tactics

The first recommended issue involves new or modified tactics. The capabilities of TERM suggest new ways for the company/team to fight. For instance, with the standoff capability of TERM, the tank company/team can fight a true delay, trading space for time, continually fight the enemy at BLOS ranges while refusing decisive engagement. Major Edwards describes the opposite tactic, advancing and attacking enemy formations on the move.[51] TERM may also promise modifications to breaching operations. With extended ranges, units may now mass overwhelming fires without physically concentrating themselves on the battlefield and becoming an artillery target. All three tactics take advantage of the increased lethality and extended ranges of TERM.

Logistics

With new tactics and an expanded battlefield, all elements of the Army's battlefield structure are expanded. How does a Task Force commander talk to company/teams spread over what was previously a brigade frontage? How are units

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[51] Edwards, 3.

resupplied on this ever-expanding battlefield? With the ability to destroy the enemy with smaller units at a faster rate an increase in tempo results. How does the logistics system support this increase? All three questions deserve further study and evaluation.

Training

New capabilities promise new challenges to training. An important conclusion of this study is the importance of improved situational awareness and the sensor-to-shooter relationships required to achieve decisive TERM fires. The company/team must now fight its traditional close fight as well as a new and dominant deep fight. In a period of shrinking resources, how does the company/team conduct the additional training required to maximize the use of TERM? This question presents daunting challenges to the armor force in the immediate future.

Integration of Other Assets

The term "tank company/team" suggests elements in a tank unit other than tank platoons. This study chose to ignore the implications and impacts of attachments to the tank company/team, particularly those of mechanized infantry. In an expanded battlespace, how does the commander employ infantry assets? Infantry may find employment as additional target designators (scouts) or as designated close fighters. Further study might suggest that they equip themselves with extended range munitions of their own. An additional consideration might include the implications of attaching a tank platoon to a mechanized company/team. These considerations, and many others, recommend themselves to further study.

Environment

This study confined analysis to a desert scenario. A host of alternative environments present several issues to the use of TERM. For instance, how does the company/team maximize TERM in Military Operations in Urban Terrain (MOUT)? Geometry considerations with TERM, particularly TERM-KE, may impose severe limits on the firing of TERM in an urban environment. However, geometric challenges may be minimized by onboard the computer power of the M1A2. Situational awareness and computational power may suggest positioning of both sensor and shooter to overcome constraints of terrain. The same positioning issues exist in mountainous and jungle environments. Consideration of TERM in different environments clearly suggests further study and analysis.

Military Operations Other Than War

This study focused analysis on conventional warfare. However, in today's uncertain world, Military Operations Other Than War (MOOTW) are the most probable tactical or operational environments for the tank company/team. How does the company/team maximize TERM in MOOTW? The precise nature of TERM provides the company/team the advantage of accurately destroying targets with indirect fire while minimizing collateral damage, an important consideration for MOOTW. TERM allows the company/team to mass fires without massing formations, allowing increased presence throughout an AO, and extended range may provide an ability to influence events outside an AO. Full consideration of TERM in MOOTW may reveal unique capabilities or limitations for the company/team commander. This consideration proves more

compelling with MOOTW as the most likely operation for tank and armored forces in the foreseeable future.

Summary

In summary, TERM presents many issues not addressed by this study. Consideration of tactics, logistics, training, integration of other assets, environment, and MOOTW require further analysis. While this thesis focused on understanding and maximizing the benefits of TERM at the tank company/team level, it may well serve as a start point for further analysis.

GLOSSARY

Battlespace. The physical volume which the commander seeks to dominate.

Basic Load. The standardized quantity of TERM per tank within the company/team.

Close battle. The portion of the battlefield that the company/team fights at direct fire ranges.

Command and Control. Functions that are performed through an arrangement of personnel, equipment, organization and procedures employed by the commander to accomplish the mission (noun). The act of applying these functions to accomplish the mission (verb).

Course of Action. A distinct grouping of an organization (pure company, mixed company, mixed platoons) with a fire control procedure (sensor-to-shooter, company commander, platoon leader control).

Deep battle. The portion of the battlefield that the company/team fights at BLOS ranges.

Decision making process. The use of weighted decision criteria to numerically evaluate each course of action. The sum totals of the evaluation determine the best course of action.

Digitized. The use of electronic means to increase situational awareness on the battlefield. The digitization of the M1A2 provides electronic enhancement of communications, location, and targeting.

Doctrine. Fundamental principles which guide an armed forces actions.

Loss Exchange Ratio. The ratio of enemy to friendly losses.

Organization. The physical structure of a unit in terms of equipment, personnel, and command relationships.

Overkill. The employment of one or more rounds towards an already destroyed enemy target.

Personnel. The position and duties of the members of an organization.

Probability of Kill. The probability that a target will be destroyed once hit by a TERM round.

Procedure. The application of a standardized action to perform duties oriented on accomplishment of the mission.

Sensor-to-shooter. A relationship wherein the sensor directly hands off a target for a shooter to engage.

Situational Awareness. The mental ability of a soldier to view the battlefield, understand his relationship to friendly forces, enemy forces, and terrain with regard to time and space.

Standoff. An advantage in weapon's range over an enemy's similar system.

APPENDIX A – PANEL OF EXPERTS

On February 10, 1998 from 0800 to 1030, a group of nine officers met to determine the weighting of criteria to for the best command and control configuration with regard to Organization and specific aspects of fire control Procedure. The panel determined the following weights (more is better):

Weight of 3: LER
Percent Kills BLOS
Percent Scouts Destroyed

Weight of 2: Percent Direct Fire Kills Beyond 3000 meters
Average Rounds Fired per Kill

Weight of 1: Leadership
Frequency of Backup-shooter-engagements
Percent Overkills

The panel was composed of nine CGSC students, two armor officers, three field artillery officers, two infantry officers, one aviation officer, and one military intelligence officer. Officers were selected based on tactical training and experience, intellectual skills, and interest in the subject. General statistics of the group are listed below.

Year Group (average):	1985	
Number with combat experience:	5	
Undergraduate background:	Science related - 7	Humanities related - 2
Postgraduate background:	Science related - 6	Humanities related - 1
Commissioning Source:	USMA - 7	ROTC - 2
Company Command time (ave.):	21 months	
Levels of Staff Experience:	Battalion - 7 Brigade - 3	Division - 5

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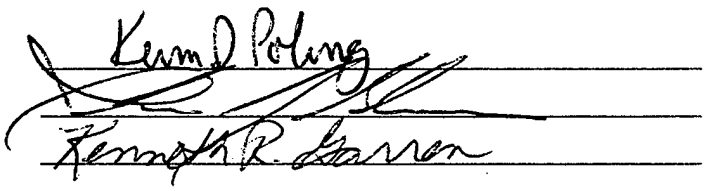

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